BRITISH FIGHTER PLANES

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by

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ILLUSTRATIONS

ditions is not yet proven. (*Photograph: Rudy Arnold, Floyd Bennett Airport, N.Y.*)

Above, The Douglas DB.7a, primarily a bomber, but developed by the U.S. Army Air Corps as a 'Three-seat Attack Bomber', which can be used as a night-fighter, like our Beaufighters. The type shown has two Wright Cyclone motors of about 1,000 h.p. each. In the R.A.F., it is known as the 'Boston'. Note the tricycle undercarriage. *Below.* The Brewster XF2A-2, or Export Model 339, known in the R.A.F. as the Buffalo, for obvious optical reasons. It has one Wright Cyclone of 850 to 900 h.p., and should be a useful advanced trainer. (*British Official Photographs.*)

Above. The Bell P.39, or 'Airacobra', adopted by the R.A.F., as the 'Caribou'. It is the world's most original single-seat fighter. The Allison motor, of 1,000 h.p., is in the middle of the fuselage, on the Centre of Gravity, and drives the airscrew by a long shaft, through which a 37 millimetre (1½ inch) cannon-gun fires. It also has four, or six, rifle-calibre machine-guns in the wings. The pilot is so far forward that he has a better view ahead and below than in any other single-motor aeroplane, as may be seen. This type has a top speed of well over 400 m.p.h. A reliable report says that it has been dived at about 650 m.p.h.—not a record, but the highest diving speed recorded. It has a tricycle undercarriage. *Below* is the Bell XFL-1, known as the 'Airabonita', which is the U.S. Navy's version. It differs from the

'Airacobra' only in having a tail-wheel and arrester-hook for deck-flying, instead of a tricycle under-carriage with a nose wheel, and, consequently has the main wheels farther forward. (*Bell Company's photographs*.)

PART I

BRITISH FIGHTER PLANES

Chapter 1

THE FIGHTER'S PLACE IN AIR WAR

An examiner, according to legend, once asked a subaltern in a crack regiment of horse, 'What is the function of cavalry in war?' and the lad answered, 'To give tone to what would otherwise be a mere vulgar brawl.' Alas, the glamour and romance of shock-action cavalry has passed. But its mantle has descended pretty accurately on the fighter squadrons of the Royal Air Force, and in these days the mechanically minded youngster, and many an oldster, is as keen on the points and breeding of the high-speed fighting aeroplanes of this war as were his grandfather and great-grandfather on those of the horses of our glorious cavalry of the Napoleonic and Crimean and many other wars.

Mind you, I am not exalting the fighters with any idea of decrying the big bombers or the light bombers, or the general reconnaissance machine, or the big flying-boats, or even the quaint craft of the Fleet Air Arm or of the Army Co-operation squadrons. Each of them is playing its part nobly in winning this war—and we still have a lot of winning to do. But the thoroughbreds of the fighter squadrons, like the finely bred horses of the cavalry, have an attraction for the romantically-minded public which is lacking from the bigger stuff, just as it is lacking from the useful, cross-bred Suffolk Punches of the field-guns, and from the great Shire horses of the siege artillery, magnificent as they were, and are.

The cavalry analogy goes farther than one might think. I asked a pilot of the last war who, in spite of being over forty years of age, and having only one hand and one good eye, habitually performs aerobatics in Hurricanes and Spitfires—of which he has flown as a delivery pilot about 150 different machines—what really is the difference between the two types. 'Well,' he said contemplatively, 'flying a Spitfire is like riding a well-trained race-horse. Flying a Hurricane is like riding a perfect hunter. Which you prefer depends on what you want to do.'

If one puts those two aeroplanes first it is because they are the real speed-beasts—the Hawker firm and Vickers-Supermarine deserve the honour. But other fighters have done their bit as well, and must not be forgotten. There is the Gloster Gladiator, which, because of its agility might be compared with a thoroughbred polo-pony. There is the Boulton-Paul Defiant, slower but, at close quarters, deadly in its own way, which might be considered a parallel to the big bony horses of the Lancer regiments, which had to carry lance, sabre, and carbine. And there is the long-range twin-motor Bristol Blenheim, which may rank with the long, rangey (in the horse sense) Walers of the Australian Cavalry in Palestine—the horses whom their men loved so well that at the end of the war they shot them to prevent a soulless Government from selling them to the local Arabs—the Canaanite agriculturalists, not the Bedouin.

There are more and newer and faster fighters to come, with much longer range and greater gun-power, but, although some of them are in R.A.F. service squadrons—several squadrons of some types exist—nothing may be said about them at the time of writing. The Americans, on their radio and in their papers, profess to know all about them, and so the Germans know as much. But what they say is not necessarily accurate. They may in time say, like

the Queen of Sheba to Solomon, 'Verily the half of it was not told me.'

HOW THE FIGHTERS HAPPENED

Obviously the job of the fighters is to fight. But the bombers fight too. So do the flying-boats. And so, even, do those funny little old trainers, the Avro Ansons, when set upon. The difference is that the fighter's job is to go and look for trouble, to go and start something, as the Americans say.

Originally, at the start of the War of 1914–18, the single-seaters were called 'Scouts'. The idea was that they should be flown by Navy or Army officers who could recognize ships or 'could read troop-movements'—that was the official phrase—because the mere ignorant civilians who joined the Royal Naval Air Service and the Royal Flying Corps were only fit to hand bombs over the side at the enemy or shoot rifles at them. The Scouts were much faster than the lumbering two-seaters, so the sailors and soldiers took them.

The first of them were the Sopwith 'Tabloid', ancestor of the Hurricane, and the Bristol Bullet, ancestor a long way off of the Blenheim, but directly the ancestor of the Bristol Bulldog, a single-seat fighter which only passed out of the Service a few years before this war.

The Spitfire's pedigree is more complicated. But the romances of those pedigrees will appear in their proper places.

After a while the Navy and Army found that an intelligent civilian soon became as good a scout as a moderately dull sailor or soldier, and that scouting could be done better from a two-seater, in which one man flew and the other made notes. Also, after shooting out of single-seat scouts with revolvers, people began to think of how to fix machine-guns in single-seaters.

Roland Garros, one of the greatest of French pre-1914 pilots, fitted little steel plates to the blades of his airscrew,

which deflected the bullets which would otherwise have shot holes in the blades. Some of our R.N.A.S. pilots did not even bother to do that, but just let the bullets make the holes, and changed airscrews when they came down—but that was not good business, and sometimes the blades broke in the air.

Then Anthony Fokker, later the famous Netherlands designer of air-liners, then a mere youth in Germany, designed a gear which fired the machine-gun at the split-second when one blade had passed in front of it and the next one had not arrived. This was called a synchronizing gear.

At just about the same time a Rumanian in England, named Constantinesco, invented a hydraulic gear that stopped the gun from firing when the blade was in front of it. That was called an interrupter gear.

And a young Australian named Kauper, who had come over in 1911 with Harry Hawker (of whom more later) to join the Sopwith Company, invented another synchronizing gear. And I remember rather vaguely a Vickers gun-gear invented by a Russian ending in ski. So, by 1915 or thereabouts, all was set for the production of real single-seat fighters more or less as we know them.

But in fact the first aeroplanes designed intentionally as fighters were two-seat 'pushers'—that is, with a real *propeller* behind, and not a tractor-screw in front. The Vickers 'gun-bus' biplane was flying in 1913–14. Henry Farman and Voisin biplane pushers were tried out with guns in front on swivels in 1912. The very first of the world-famous De Havillands, the D.H.1, was a two-seater biplane with a gun in the nose.

Advancing a step further, the D.H.2 was a single-seat pusher biplane with a swivel gun. The pilot flew with one hand and waggled the gun with the other, or, if he liked locked the gun and aimed it, like Judson's historic flat-iron gun-boat, in Kipling's story, 'by wearing ship to suit'.

The historic, or notorious, Royal Aircraft Factory at Farnborough—now the Royal Aircraft Establishment—brought out the F.E.8 on almost identical lines. And both did good work till about the middle of 1916, when the tractor type, naturally faster because of its better streamlined shape, was fitted with twin synchronized, or interrupted, guns in front, and just wiped everything else out of the air.

All these early fighters were biplanes, in spite of Lord Northcliffe's *ex cathedra* statement, when Blériot flew the Channel in 1909, in a monoplane, that the biplane was dead. And, as I will show later, the biplane is still going strong. Nevertheless, history might have been altered, for Captain Frank Barnwell, the designer of the Bristol Bullet, produced in 1916 a Bristol monoplane single-seat fighter which all its pilots said was the best thing that ever happened.

Unfortunately, when the question of building it in quantities came to be settled, it fell into the hands of a fairly senior and not-so-good pilot who, as the R.A.F. would say to-day, boobed his landing, and blamed the consequent write-off on the machine. So, the dozen or so that had been built for squadron test were sent to Palestine, where they played merry hell—to quote one of their pilots—with Johnny Turk's German biplanes.

That is how history is sometimes deflected from its proper course. I only hope that we make fewer mistakes in this war than we did in the last. But I doubt whether we shall. There are more of us.

WHAT THE FIGHTERS DID

In the last war, as in this, the fighters were fast short-range craft. As they and their armament developed their jobs became more specific and defined. A curious fact is that, barring higher speed and heavier armament, nobody seems to have found any fresh use for fighters in this war.

Primarily the fighters' job was, and is, to stop enemy bombers or reconnaissance or photographic machines from coming over our territory. That meant fighting on our side of the line—or to-day, of the Channel and the North Sea.

The other part of their job was to fly in formation over enemy territory, commonly called Hunland, as escorts, and beat up any enemy fighter formations that were trying to shoot down our bombers and photographers. Also they shot down artillery-observation machines parading up and down behind the enemy lines. Another of their jobs was attack, often along with bombers, on enemy aerodromes. Many pilots specialized on lone-hand attacks on special objectives, and carried light bombs. All of which can be translated into terms of to-day's war.

Later on the fighters took on attacking troops in trenches, on roads, and in the open in Hunland. This was called trench-strafing or ground-strafing, from the German *strafen*, to punish or strike, as in the entertaining 'Hymn of Hate', with its refrain—'Gott strafe England'. The words and music reached England through a neutral country. We looked upon it as an uproarious joke and in certain of His Majesty's ships the Ward Room used to sing it as a regular after-dinner ritual.

And to-day ground-strafing is still part of the fighters' job when we operate against troops on the ground. The Gladiators in Egypt and in Libya have already done a lot. They are quite well suited to it, for they are not too fast and are very quick on their controls. High-speed eight-gun fighters are wasted on such work, but they also have had to do it, for lack of proper ground-strafers.

At the end of the last war both the German's Junkers Company and the British Sopwith Company had designed real ground-strafers, the guns of which fired at an angle downwards while the aeroplanes were flying horizontally. Fixed-

gun fighters, obviously, can only fire at the ground while diving, and so can only be momentarily effective. Still, they are very frightening, and that is something.

At the finish of the last war, on the 11th of November 1918, in case you have forgotten it, the best single-seat fighters were the Sopwith Camel and Snipe and the S.E.5a. The last-named was produced by the Royal Aircraft Factory to the designs of H. P. Folland, who many years later designed the modern Gladiator. The place the Defiant holds to-day was held by the historic Bristol Fighter, designed by Frank Barnwell, who was largely responsible for the modern Blenheim series—Beauforts, Bolingbrokes, Beaufighters, and whatever may come after.

Chapter 2

BETWEEN WARS

After 1918 Mr. Winston Churchill, doubling the parts of Secretary of State for War and Secretary of State for Air, cut the Royal Air Force down to just one-tenth of its size at the time of the Armistice—or decimated it, in the strict sense of the word. General Sir Hugh Trenchard (now Marshal of the R.A.F. and Viscount Trenchard), who had already built up two Air Services out of nothing, one in 1914–15 and one in 1916–17, started to do it again. When Sir Samuel Hoare became Secretary of State for Air the two of them started to lay out the organization on which a great Air Force could be expanded. When Lord Trenchard left the Air Ministry in 1930 he said that they had laid the foundations for a castle, and if nobody wanted to build anything bigger than a cottage on it, at any rate it would be a jolly good cottage. To-day we see the castle, bigger perhaps than ever he dreamed it might be. And yet, so has Lord Trenchard's foresight been proved, he may in 1919 have been seeing further ahead than anyone is seeing to-day. A certain White Paper published over his signature in that year is worth studying.

Anyhow, in the years between, fighters took rather a back place. There was no real air fighting to be done because we were not at war with any power that possessed an air force.

In the wars against the Bolsheviks, when R.A.F. detachments operated from Archangel and Murmansk in the north,

and from the Crimea and the Caucasus in the south, two-seat fighters and reconnaissance machines were more useful than single-seaters.

In Mesopotamia, which we had to learn to call 'Iraq, where Sir Samuel Hoare and Sir Hugh Trenchard arranged for an Air Force officer, Sir John Salmond, to take over the command from the Army and instituted the system of 'control without occupation', two-seaters were better craft for the job.

On the North-West Frontier of India, where we have for most of a century tried to stop the Pathan hill-tribes from cutting the throats of millions of Indians who are incapable of defending themselves, the good old Bristol Fighter, transformed into an aerial Christmas-tree with bombs and bedding and beer-bottles, was used to bomb the tribes into decent behaviour, even though they could not learn to love their neighbours.

The last appearance of single-seat fighters in action was at the time of the Chanak trouble with Turkey, when Mustafa Kemal, later called Kemal Ataturk, was rising to power and took a hostile view of our occupation of Constantinople (now officially Istanbul). The Turks were slipping soldiers disguised as civilians across the Bosphorus, and had nearly enough in hand to outnumber our little garrison under General Sir Charles Harington (since deceased).

Then one day the R.A.F., stationed at San Stefano outside the city and on the Gallipoli Peninsula, put up a show, led by their Commanding Officer, Group Captain Peregrine Fellowes. Every available aircraft took off and circled over the city. The Turks thought that the floats of the seaplanes were colossal bombs.

Just when everything was going wide open and all the 'Turks, Jews, Heretics, and all the Pentecostal sweepings of the East', as a writer of centuries earlier had called the Con-

stantinopolitans, were out in the streets gazing upwards, round the corner of the Golden Horn, almost on the water, swept the last six Snipe[1] of No. 1 Squadron R.A.F. Up the main street from the harbour they flew, level with the housetops, in line ahead, machine-guns blazing blank cartridge, motors howling at full throttle.

At the end of the street they did Immelmann turns (half-loops with cart-wheel turns on top), charged down the street again in line, and so back peacefully to San Stefano. That was the last active service of our single-seat fighters till this war began. And after that the Turks in Constantinople would eat out of our hands. To-day the Turks are our good friends, as they were in the Crimean War.

Nevertheless, Sir Hugh Trenchard never lost sight of the future usefulness of single-seat fighters. There were always fighter squadrons in the R.A.F., although the majority of its machines were of what were called officially General Purpose types, suitable for reconnaissance, bombing, communications, or anything else, against tribes that had no aircraft —the kind of thing the realistic French called 'Colonial warfare', intended to keep the indigenes of colonies in order.

Our between-war single-seaters were a motley lot. At first we had left-over Snipe. Then came Siddeley Siskins, built most elaborately of strip steel, and there were Gloster Grebes and Bristol Bulldogs, built of wood and wire, all in full squadrons, besides sundry experimental types, built singly or in half-dozens.

In the 1930's came the famous Hawker series, built of steel tubing covered with fabric, culminating in the Fury, of which more will be said in the chapter on the Hurricane. And with them was developed the Hawker two-seat fighter called

[1] The plural of Snipe is, I believe, Snipe. One talks of a brace of snipe, but a brace of partridges, and, *strictly*, of a brace of 'grice'!

the Demon, a variant of the Hart reconnaissance biplane. In it the first Frazer-Nash gun-turrets were tried out.

There was also the Fairey Flycatcher, alleged to be the only aeroplane a ham-handed naval officer could *not* pull to pieces in the air—and correspondingly slow, but sure. But after it came the Fairey Firefly, one of the loveliest biplanes ever built.

Mr. Fairey also produced the Fantôme, with an Hispaño-Suiza *moteur-canon*, the first British cannon-gun fighter. Unfortunately it was not approved, although the French had used cannon-fighters in 1918. To be too soon is as bad as to be too late when dealing with Government departments. And to-day the Fairey designers are more interested in the needs and wishes of the Fleet Air Arm than of the R.A.F.

THE USE OF INTERCEPTERS

The Fury and the Firefly and the other fighters of this period were officially called interceptors. The idea was that they should sit on the ground, and when the coming of enemy aeroplanes was signalled from the coast they were to go up and intercept them. And people talked of air defence.

Many of us objected to the term 'air defence'. We argued that defence was the first stage of defeat, and I said then, as I have said ever since, that the word 'defence' ought to be eliminated from the English language.

Lord Trenchard, the creator of the Royal Air Force, said then that the football captain who massed his team round their own goal might avoid being defeated, but that he would never win a match. And that is truer than ever to-day. Lord Trenchard is always right—I can say so as the result of watching his work at close quarters for twenty-eight years.

Our modern fighters were the progeny of the interceptors, but nobody would accuse them of being defensive weapons. They are the most offensive aircraft ever devised. And their

descendants in turn will win the war by being still more offensive and being able to attack at greater distances.

In 1936 came the first Spitfire, and almost simultaneously the first Hurricane. The Spitfire was shown in what was officially called the New Type Park, but more commonly the Amusement Park, at the R.A.F. Display at Hendon. The next year it did not appear, because it was no longer a new type, but the Hurricane did.

The arrangement of the guns in these new types was hidden from prying foreign eyes by pasting bits of fabric over the openings for the blast-tubes in the leading edges. One of those secrets known to everybody but ourselves—as a friend of mine on the Staff used to call the hush-hush stuff in the last war.

Everyone knew that we had at last got away from the interrupter gear and the synchronizing gear, and all their weight and complication and liability to accident and error, and were firing our guns clear of the airscrew. But everyone did not know that we had eight of them or the rate of fire. That was what struck the enemy all of a heap when he felt the weight of metal.

And that brings us along—very sketchily, I fear—to this war.

Chapter 3

THE WAR OF TO-DAY

When this war began the R.A.F. had little to do—which was just as well, because although we were well up on quality we were a trifle down on quantity. The Germans sat behind the Siegfried Positions (not Line, please), and the French sat behind the Maginot Line—the 'Immaginory' Line, as some sceptics called it, even in those days.

The politicians on both sides seemed to have a mutual understanding that neither would bomb the other on land, but that each could bomb, blast, mine, torpedo, or otherwise molest the other on, in, or under the sea as they pleased. German Grand H.Q. were at Wiesbaden, a health resort rather like a super-Cheltenham. Sundry of our Government departments—as everyone knew, including the German radio—were evacuated to British beauty-spots. But there was no reciprocal bombing of health resorts.

This goaded my friend, Major Al. Williams, America's best writer on Service aviation, to the scathing remark that there was no reciprocal bombing because 'the politicians on both sides knew that it would put them in the firing-line, in two senses'. Consequently the fighters had little to do.

The Advanced Air Striking Force in France, under Air Vice-Marshal P. I. P. Playfair (now Air-Marshal Sir Patrick Playfair), had some squadrons of Hurricanes with it, as well

as its bombers. All the bombers were allowed to do throughout the winter was to make very cold and uncomfortable flights in the dark over Germany, dropping leaflets, which Mr. A. P. Herbert called bomphlets, telling the German people how we loved them but how we hated their Nazi war-lords. That cost us some aeroplanes and lives, because of landing in fog or falling out of the sky iced up.

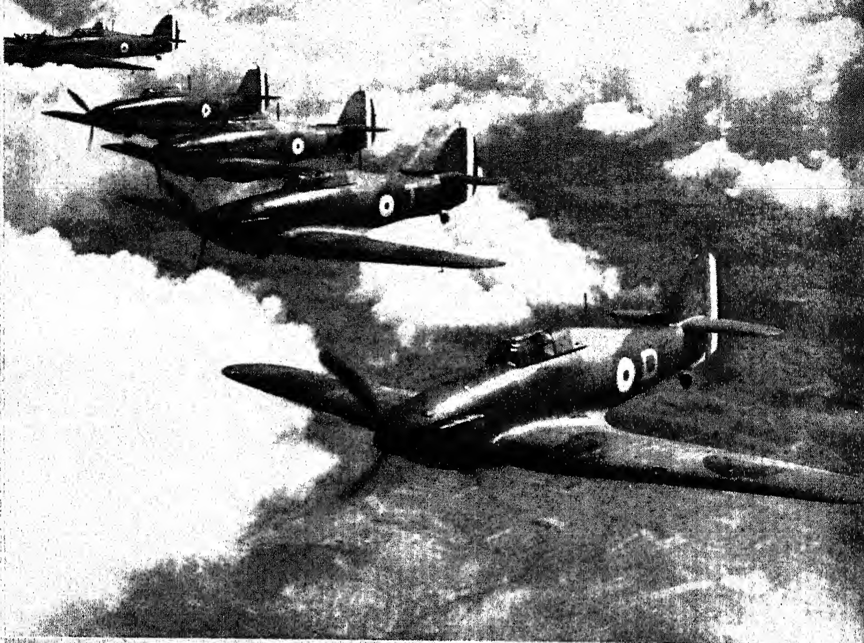
The fighters used to go over the Siegfried Positions escorting our Fairey Battle photographic machines, and jousting with the German fighters that tried to pounce on the slow, seven-year-old Battles. That was definitely a Good Thing, for it proved to our fighter pilots that their Hurricanes, and later Spitfires, were far superior in manœuvrability and fire-power to the much-vaunted Messerschmitts. The Hurricane was then, I think, a trifle slower than the Me.109, but it was all over the German if it started at a higher level and could slide down hill at him.

At home, we had Fighter Stations neatly placed to cover our east and south coasts, and the east coast of Scotland. And they soon saw service. The Germans began shooting up and bombing convoys that were being escorted up the North Sea by the little Ansons of the Coastal Command, whose real job was to scout for mines and submarines.

As the Ansons had only a pop-gun forward and another in the hump on top (the dorsal gun-position, as the pompous call it), they could not cope with Heinkels and Dorniers. By pop-guns the R.A.F. mean the old Lewises and Vickers of 1918, which fired at the rate of about 600 shots per minute. So the Ansons' wireless justifiably screamed for help.

Out to their rescue shot a few Spitfires or Hurricanes, doing their comfortable 350 to 375 miles an hour, and firing eight guns at the rate of 1,200 shots per gun per minute—think of it, 160 shots *per second.* And at first the Germans never knew what hit them.

Plate 1. Spitfire



They grew wiser after a bit, and 'took evasive action', as the Air Ministry calls it, after an attack on a convoy, without waiting for the fighters. And then our fighters had to run what the Air Ministry called 'standing patrols'. I like 'standing' at 350 m.p.h. or so. But it only means staying in the air over a regular beat, like a policeman.

Farther north the German reconnaissance machines—which our newspapers would always call raiders—used to go hunting in twos and threes for the British Fleet up round Scapa Flow in the Orkneys. And they in turn used to be hunted by our fighters, from absurd little aerodromes on the islands and on the Scottish coast.

One of these fellows was the first to break the truce about land-bombing. A bomb, doubtless intended for a warship, landed on land and killed a rabbit—the first casualty in the British Isles. Later a similar affray killed a man standing by his door watching the scrap, but whether he was killed by a bomb or a bullet I do not know.

Another day some Germans, real raiders this time, had a go at the Forth Bridge. Some officers and men on the deck of one of our destroyers were watching the performance when a German dived and machine-gunned them and killed several. One is sorry for their relatives, but gaping at air fights is an over-rated amusement.

In that skirmish a Heinkel was shot down by the officer commanding a Scottish squadron of the Auxiliary Air Force, in a Gladiator; he was a lawyer by profession. When the German officer-pilot, who was captured, was told who had brought him down he said, according to local R.A.F. legend, 'To have been shot down by an obsolete biplane is bad enough, but to have been shot down by a lawyer is too much,' and burst into tears.

I am sorry to say that the gallant lawyer was himself killed in action in the autumn of 1940, after a brilliant if brief

Plate 2. Hurricanes and Spitfires

career as a fighter pilot in which he won well-deserved decorations. None enjoyed more than he the story of the aggrieved German, who obviously did not know the fighting power of the Gladiator or the ferocity of Scottish lawyers.

THE FIGHTERS MAKE HISTORY

This kind of desultory skirmishing went on till the 'Sitzkrieg' between the Siegfried Position and the Maginot Line ended, and the Blitzkrieg began.

In Norway our fighters never had a chance. Our politicians in power at the time let the Germans jump the only aerodromes in Norway, when, if we had been wiser, we should have got there first. When our troops landed north and south of Trondhjem they were just blasted out of the country by German bombers.

If we could have used fighters we could have kept the bombers down, but there was no place from which to operate.

A squadron of Gladiators (again those Gladiators), whose pilots had never flown off a deck, were embarked in an aircraft-carrier, which took them as near the Norwegian coast as would keep it out of danger of torpedoes and bombers. Thence the Gladiators flew to a frozen lake, and from there for a day or two they fought a brave but lost battle against the bombers.

That story needs a Kipling to tell it. The Germans bombed the ice, and even as it flooded and sank under them, the last of the Gladiators took off with their wheels in the water, and fought till their ammunition was gone. Then they landed and crashed on the snow-bound roads.

It was a gorgeous show; and I gather that the squadron's casualties were light, considering what they did. The Air Ministry smothers stories of this sort—which should be told as widely as possible by the best writer available—somebody

like the sailor-man who wrote 'Prelude to Dunkirk' in *Blackwood's* for August 1940—and it wastes reams of paper on half-baked communiqués and bulletins through which even a professional student of history could not wade without nausea.

After we had been ignominiously kicked out of Norway—which was to have been 'Hitler's Peninsular War', according to one optimistic politician—the real Blitzkrieg started.

The German Armies had been for months lining up along the frontiers of Holland and Belgium, all duly photographed by our new high-speed photographic machines. But never a bomb was dropped on them. Then one day they burst through.

Everybody knows the stories of the parachute troops, disguised as nuns, with folding bicycles, radio sets, and tommy-guns draped gracefully all at once in their garments, and of troop-carrying aeroplanes which disgorged tanks and field-guns and pit-ponies. Actually most of the occupation was done by German troops who came down the Waal and the Schelde in barges. But the parachute troops, mostly in uniform, carrying tommy-guns, captured aerodromes and many important points.

Then the British Army mistakenly swung north and east from France into Belgium, and the Germans broke through at Sedan, in what a politician facetiously called 'The Battle of the Bulge', which became the spear-head of a great thrust for the Channel Ports, according to the Schlieffen Plan of 1914—only this time the German tanks did what von Kluck failed to do. And the British Army was cut off from France.

Its only way out was at Dunkirk. It made for the port as best it could, shedding all its equipment as it went. The retreat to Coruña was a picnic compared to it. We looked like losing most of 400,000 men.

They were bombed on the roads and in the fields, and

machine-gunned. They could not hit back effectively, either at the German bombers or the tanks.

Then the Royal Navy took a hand in getting the men out, and the fighter squadrons of the Royal Air Force cut loose on the German bombers.

For the first time the fighters were able to work as they were intended to work. The war had come so near that they could start out from their own aerodromes in England and kill and kill till they had no ammunition left, and then come home to breakfast or lunch or tea while the ground-crews were refuelling and re-arming their machines.

At first the Spitfires and Hurricanes did all the work. They were up against the Junkers Stuka (Ju.87) dive-bombers, and the old familiar Heinkels and Dorniers. There seemed at that time to be few Messerschmitt fighters about. They were probably busy in France machine-gunning the French armies, which had practically no Air Force to protect them. And the German High Command wanted, before all, to cut off the British Army, so it concentrated its bomber force on that.

Then, when the Spitfires and Hurricanes were going strong, the R.A.F. Fighter Command let go the new Defiant two-seat fighters on the German dive-bombers. This machine, although it was out on test in the summer of 1939, had never been in action before. The pilots and gunners had been kept at home practising their new tactics.

The Defiant had no front guns, but it had a power-driven four-gun turret amidships. Instead of the pilot going where he liked, his job was to put the gunner where he wanted to go. It was a new tactic based on the fact that nobody believed that a broadside fired from an aeroplane diving at about 300 m.p.h. could be effective—just why I will explain more technically later.

Consequently, when the Stukas dived to bomb, the pilot with his nose on his target like a hen with its beak on a chalk-

line, a Defiant would come sliding down behind, but wide of it, outside the restricted angle of the Stuka's aft gun. The Defiant would range alongside, edge in till it was in what would be called close formation, and then the four guns would hose a stream of bullets into the Stuka's bowels which generally caused it to burst asunder in the midst.

Between the Hurricanes, Spitfires, and Defiants the German bombers were massacred. We shall probably never know their losses. Our own losses were fantastically small, considering the execution our fighters did.

The sad part of the show was that the British Army, and some few Frenchmen who had not surrendered, crushed together on the roads and on the docks, and spread out defenceless on the beaches, never knew what the R.A.F. was doing for them. They only saw the German bombers which got through. Naturally they never saw the Germans who were shot down before they came within sight of our troops on the ground. And they certainly never saw, in the fog of battle, the hundreds of British fighters high up, dealing faithfully with the bombers as wave after wave came in sight.

The British Navy may not be strong on organization, but it can improvise against anybody. And never has its genius for 'makee-do' had such a chance as at Dunkirk. Every longshore-man, and several longshore women, between Plymouth and Yarmouth seem to have concentrated at Dunkirk. Barges, yachts, trawlers, hoys, even London's fire-floats and Dutch scows commandeered in territorial waters, dinghies with outboard motors, anything that would float, took the men off.

An engineer officer of the Fleet Air Arm, formerly of the Royal Naval Air Service in 1918, to my knowledge more than sixty-five years of age, was *ordered* by his admiral to take ten days' leave, because he had worked himself to the verge of a breakdown while the affair in Norway was on. He

took his leave protesting, and spent it with a pal in various boats off Dunkirk. He said it was the best leave he had ever had.

Without the R.A.F. fighters the miracle of Dunkirk could not have happened. We got 335,000 men out. They lost all their transport and arms. Some few brought their rifles with them. But the men came back.

Under God—given the British Navy, and a week of perfect calm, and two days of fog at the end, in which to clear the last of the beaches—given all that, those men could not have got away if the R.A.F. fighters had not kept the bombers and machine-gunners off them.

Chapter 4

THE WAR ON THE HOME FRONT

And now we come to the next phase, which brought the war close home to us—the mass attacks on England.

They began in July with attacks by big formations of dive-bombers and heavy bombers, escorted by fighters, on convoys of the little merchant ships that were bringing our supplies to the Port of London through the Straits of Dover. Our fighters swept out from the fighter stations in the south-east of England, and massacred the Germans, as they had done in Flanders.

Here for the first time our fighters met regular formations of the Messerschmitt 110, the two-motor, two-seat fighter which was doing its first trials when war was declared. Rather to their surprise the Spitfires and Hurricanes found that, in spite of the guns aft in the 110, they could break up these formations almost as easily as they could smash the 109 single-seaters. All of which raised the spirits of the Fighter Command immensely.

At this point I may remark that all this fighting along the south-east coast was done by the Fighter Group Commands in the south and east. The Groups in the Midlands and north were kept in their own areas ready to meet any attacks the German High Command might make on the coastal towns of the North Sea and the industrial areas of the Midlands and north of Scotland.

Naturally squadrons that were tired with much fighting, or had lost many men and machines, were sent to other areas to rest and re-equip, and fresh squadrons which were itching for a scrap and a chance of distinguishing themselves were transferred to the southern Groups. But at no time since the attacks on Britain began has the strength of the Midlands and north been weakened to support the south.

Another interesting point is that although our fighters began life as interceptors, as explained earlier, they showed in Flanders, and have gone on showing ever since, that they are in fact the spear-head of attack. On this I will say more later.

From attacks on convoys in the Channel the Germans progressed to huge mass attacks on south coast cities and towns. Portsmouth was virulently bombed—so much so that the Censorship admitted the attacks—and so were Southampton, Brighton, Eastbourne, Folkestone, Dover, and smaller towns inland, and towns in Essex and Suffolk.

The co-operation between the fighters and the anti-aircraft guns—called Archie-guns by the older R.A.F. people, and *flak-artillerie* by the Germans—became superb. A colonel of the Regular Artillery said that he arrived at Portsmouth by train in the middle of a big attack. As he walked out of the station the Archie-guns were roaring like the barrage on the Western Front before an infantry battle in 1917. Suddenly the guns stopped, as if turned off by one switch. Then for a few seconds there was a terrific noise high up, and down swept squadron after squadron of our fighters, out over Spithead and the Solent and the Isle of Wight, and the German bombers and fighters began falling out of the sky, as he put it, like birds at a big pheasant shoot.

As an experienced soldier, he said that it was the grandest battle he had seen, for it showed the fine spirit of the youngsters in the fighters, the excellent training of the advanced flying schools, and the accuracy of the staff-work in Group

and Command Headquarters which put all those fighters into action from different stations on the dot of time. When the old Regular Army talks like that of the youngest Service the R.A.F. can modestly pat itself on the back.

Just why the German High Command kept on hurling these masses across the Channel is not clear. They may have hoped to weaken our fighter force by killing off a lot of our best pilots—in ignorance of the fact that there are no *best* pilots in the R.A.F. because so many are first class.

Their idea may have been that if they could weaken our fighters they might clear the way for an invasion by parachute troops, troop-carrying aeroplanes, and sea-transports. Evidently the first stage of any landing on an enemy coast must be to get command of the air over that coast.

There the Germans failed badly, because, although they shot down many of our fighters, a high percentage of the pilots got down safely by parachute, or landed their damaged aeroplanes, or came down in British waters and were rescued. On the other hand, every German who came down, whether dead, wounded, or unhurt, was a total loss to Germany.

I like the story of the R.A.F. sergeant who was escorting an unhurt German prisoner through a south-eastern town when the German, who had evidently been told that German armies had occupied parts of England, asked him where the nearest German troops were. The sergeant, jerking his thumb towards what was obviously the local jail, replied simply, 'In there.'

From attacks on the Channel towns the Germans went on to attacking London up the Thames Estuary, also in great force. Again the fighters chewed them up. Few got through to London in daylight, so long as the weather was fine and the fighters could see them.

The Germans tried big formations of bombers, with normal fighter escorts. Then they tried using bigger fighter es-

corts stepped up in layers one above the other. They washed out their dive-bombers and used only the big Heinkels and Dorniers. Then they took to using the fast twin-motor Messerschmitt 110's as bombers, because they are harder to catch.

The table which follows shows the results. And remember that our official figures can be trusted. No R.A.F. pilot (or crew) is credited with having brought down an enemy aircraft unless it is confirmed by a witness, either another aviator, or somebody on the ground or at sea. Here are the figures for the attacks on England, up to the end of the first year of war:

Week	*German Losses*			*British Losses*		
	Fighters	*Bombers*	*Total*	*Fighters*	*Pilots saved*	*Net loss*
July 8–14	84		84	17	*Pilots saved in these weeks were not announced*	
15–21	22	24	46	10		
22–27	29	28	57	9		
28–Aug. 3	16	31	47	8		
Aug. 4–10	42	27	69	20		
11–17	214	281	495	115	46	69
18–24	89	154	243	51	30	21
25–31	182	115	297	113	68	45
Sep. 1–7	192	151	343	118	61	57
Total in Nine Weeks	786	811	1,681	461	205	192

The big German bombers carry crews of four or five, and many of their fighters are two-seaters, so one may take their losses in men as an average of three per aeroplane. Thus their attacks on England in those nine weeks cost them at least 5,000 airmen (pilots and bomber crews), against a loss of 192 fighter pilots of the R.A.F.

To give a still fairer measure I may add that during the eight weeks from July 15 to September 7, when we were

bombing Germany hard by night, we lost 131 bombers, which, averaging them also at three men per machine, gives a loss of say 400 men. Which brings the total losses of the R.A.F. by enemy action to roughly 600 men against a German loss of roughly 5,000.

So now you see how right Air-Marshal Sir Philip Joubert de la Ferté was when he said in a broadcast, while the fighting in Flanders was still going on, that the R.A.F. regarded 3-to-1 against as normal odds, and were ready to tackle 10-to-1 if needs were.

The three great days of the R.A.F. were August 15, when they brought down 180 German machines, September 15, when they brought down 188, and September 27, when they brought down 133.

Later information seems to show that the attack on September 15 was a preparation for an attempted invasion of England, for on September 16 the R.A.F. and the Navy caught a large force of German troops in boats some miles out from the French coast and sank such a number that the Germans killed and drowned were estimated at many thousands. Whether it was a real attempt at an invasion or merely an elaborate dress rehearsal has not been officially stated.

All of the R.A.F. were glad to share in the distinction when on October 1 His Majesty the King was pleased to appoint Air Chief Marshal Sir Hugh Dowding, G.C.V.O., K.C.B., C.M.G., to be a Knight Grand Cross of the Military Division of the Most Honourable Order of the Bath—the highest possible military decoration.

Sir Hugh had been Air Officer Commanding-in-Chief the Fighter Command for two years before war was declared, and had been officially responsible for building up the fighter organization. He was one of the pioneers of Service aviation, for he joined the Royal Flying Corps in its earliest days, in 1912, went to France with one of the historic First

Four Squadrons in 1914, and has held most of the important Commands, operative and technical, in turn.

He was an officer of the Royal Artillery, and his career is evidence of the value of the training of the Royal Military Academy at Woolwich, commonly called 'the Shop'.

CHANGES IN STRATEGY AND TACTICS

After the failure of their mass attacks had convinced the German High Command that domination of the air over England is impossible, they changed their tactics. Bombers and fighters were sent over singly or in twos and threes. And, as the weather broke in September and the sky became more cloudy, our fighters became busy hunting the raiders in and out of the clouds.

The attacks were spread all over Great Britain. The B.B.C. announced reproachfully that the Germans bombed beauty spots and innocent country towns and houses in open country—evidently forgetting, or not knowing, that for years German armament work has been done in 'dispersal factories' in country places in a way which amounts to making it a village industry. That was why our night raiders set fire to the German beauty spots in the Black Forest and the Harz Mountains, where we knew their small-parts factories were dispersed.

The results of these hide-and-seek scraps in the clouds have naturally not been so great as when hordes of enemy aircraft presented themselves as targets. But the fighters have been doing steadily well.

The last phase has been attacks on London and our industrial areas and ports at night. Nobody has yet invented a reliable method of catching enemy aeroplanes in the dark, and our night-flying fighters have to depend on being somewhere handy when searchlights pick up and hold an enemy machine.

That is where we were at the time of writing. The puzzle had been solved before this book appeared. But the night-fighter formations were waiting for supplies of machines fitted with 'the delicate instruments' to which a guarded but illuminating reference was made in an Air Ministry communiqué in January.

A measure of the success of our fighters, guns, and search-lights is seen in the fact that the enemy have given up using their bigger and slower bombers at night over London and are using fast fighters, Messerschmitt 109's and 110's, which make much noise and carry few bombs, but do dive in and get away by sheer speed, and because they are smaller and therefore harder to see and hit.

But the size and weight of some of the very big bombs that have fallen suggest that the Germans are using some of their big four-motor air-liners, specially faked for very high flying, where neither guns nor fighters can reach them, and are bombing blind.

Chapter 5

THE MIDDLE EAST

Although few details of the work of our fighters in the Mediterranean and Middle East reach this country, we know in a general way what they have been doing.

Air fighting started over Malta as soon as Italy came into the war. At that time only about a squadron of Gladiators represented our fighting force. Whenever Italian bombers appeared out popped the old Gladiators, shot down a few, and came home to their burrows in the rocks—according to local legend.

When, in July 1940, the High Authorities decided to reinforce Egypt—or the Army of the Nile, as it seems to be called officially—reinforcements were also sent to Air Chief Marshal Sir Arthur Longmore, Air Officer Commanding-in-Chief, Middle East. These included squadrons of Hurricanes, of which we had so many that, considering the big supply of newer fighters coming along, we could well spare some.

There were already some squadrons of Gladiators in Egypt and some Blenheim fighters, as well as Blenheim bombers. And I believe that some American fighters were also sent to Egypt.

Since then the suggestion has been made, by an ex-R.A.F. officer now in Trinidad, West Indies, that our Air Force in the Far, Middle, and Near East should be supplied altogether with American aeroplanes, because shipping trans-

port direct from California, where most of the best U.S. aircraft are made, to Egypt, by way of the Red Sea and Indian Ocean is likely to be more Pacific than by way of the Atlantic and Mediterranean. Thus the Far West would arm the Middle East.

Our long-range bombers can fly to Malta non-stop, and thence to Egypt—in spite of the sad fate of Air-Marshal O. T. Boyd, who, on his way to take up the post of Second in Command to Sir Arthur Longmore, was shot down over Sicily and taken prisoner along with the crew of the bomber in which he was a passenger.

But the fighters cannot fly so far, and must go by boat. So the idea of standardizing on American aircraft in the Middle East is praiseworthy.

During General Sir Archibald Wavell's advance along the coast of North Africa our fighters met little opposition. The Gladiators had already shown that the Italian fighters had no chance. Between July 22 and August 31—that was before the greater reinforcements reached Egypt, and while our fighters were doing so well over the Channel at home—the Middle East fighters in Malta and Egypt brought down forty-three Italian fighters and thirty Italian bombers. And in the week September 1 to 7 they brought down seventeen assorted Italians. Our losses were only two or three.

After the great advance began our people seemed to lose count. Each fighter pilot probably knew how many he had shot down or damaged, and so did the squadrons, but H.Q. reports became vague. Moreover, the fighters were doing so much ground-strafing of Italian transport and troops on the roads, and of aeroplanes and their equipment on the aerodromes, that shooting down aircraft became almost a secondary business.

Actually, unless the pilot (and crew, if more than a single-seater) is put out of action, shooting-up or bombing an aero-

plane on the ground is as good as shooting it out of the sky. And by the early part of 1941 aeroplanes had become practically Consumable Stores, so the number destroyed was hardly worth counting. Until then a tally of the number shot down had been a fair measure of the relative efficiency of the air-forces engaged and of the damage done to the enemy, and still is, so far as shooting down is concerned. But aeroplanes destroyed, if the crews escape by parachute to fight another day, do not help much to win the war.

Here let me quote a tribute to the Italians from one of our fighter pilots. He said that the Italian pilots in their little Fiat biplanes almost always turned and fought, and even climbed to fight our machines above them, before turning for home. They knew that they had no chance, but honour was satisfied by 'showing willing'.

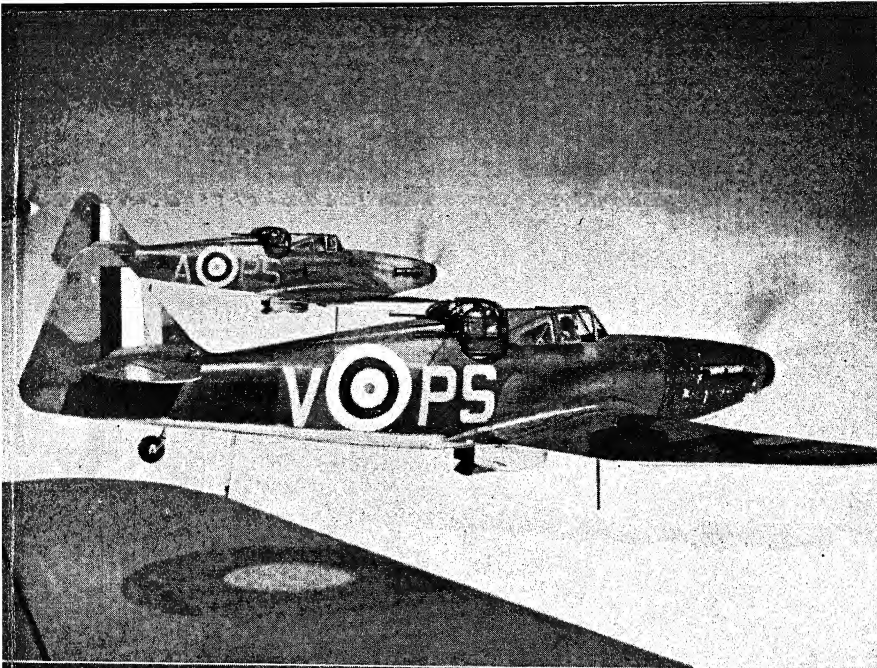
Early in the year a fresh phase of the war opened, namely, Germany's effort to keep Italy in the war so as to embarrass, rather than prevent, our supplying and reinforcing our Army of the Nile. This might be called the battles of the Sicilian Straits.

Seeing that the Italians were hopelessly beaten on land and sea and in the air, the Germans sent numbers (500 at a guess) of their Junkers 87 dive-bombers, called the Stuka, to Catania in Sicily, to attack British convoys of ships passing through the narrow waters between Sicily and Africa.

Between Sicily and Tunis the Straits are only eighty miles wide, and almost in the middle but a little east lies the island of Pantellaria, an Italian fortress which has been described as an unsinkable battleship in the fairway. About 140 miles farther east, in wider waters, opposite the Gulf of Benghazi, is Malta, only forty-five miles from the coast of Sicily and a little more than 100 miles from Catania.

Shipping on the east–west route along the Mediterranean must pass within gun-range of Pantellaria and of

Plate 3. Boulton-Paul Defiants and Blenheim Fighter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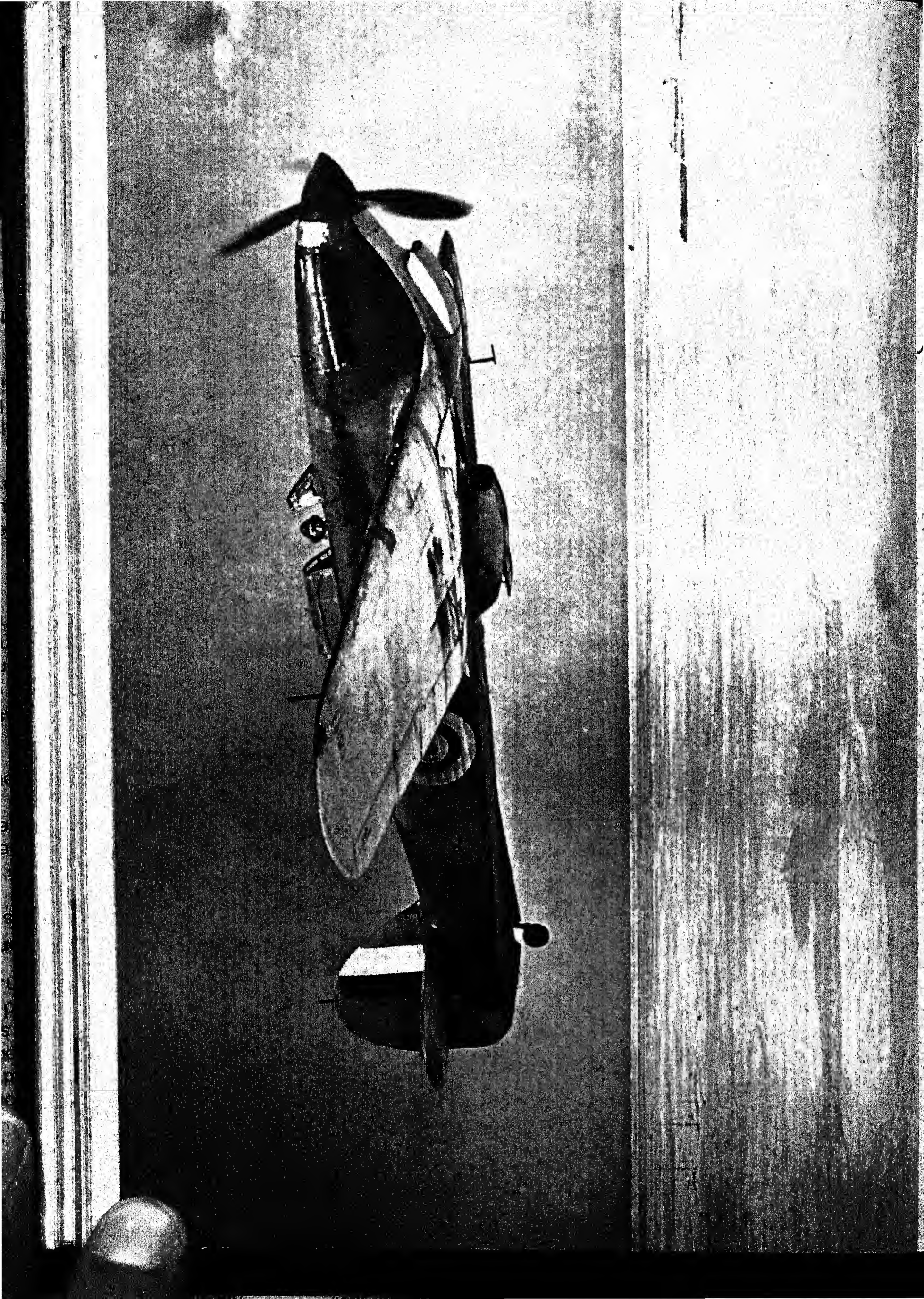


Malta, and so will be within easy flying distance of Catania or other aerodromes on Sicily for dive-bombers, for about 300 miles of its voyage. So our supply-ships must be escorted by warships to protect them against submarines and by fighters to protect them against bombers.

Thus the importance of Malta as a base for fighters is greatly increased. And so one of the first things the Germans did on reaching Sicily was to try to bomb our aerodromes on Malta. They failed badly and lost forty or fifty machines in a few days.

Likewise the Stukas put in a big attack against a shipping convoy and its escorts. They damaged H.M.S. *Southampton*, a cruiser, so badly that our own ships had to sink her. Also they damaged H.M. Aircraft-carrier *Illustrious*, our newest and best, so badly that her skipper had to bring her in to harbour for repairs. The German radio said Malta, and the dive-bombers attacked Malta next day.

Some months before the war a naval officer of high rank had described the *Illustrious* to me as an almost unsinkable ship. She lived up to her reputation. Moreover, fleet-fighters, presumably Fairey Fulmars, from her deck, destroyed many Stukas, and so did the fighters from Malta. So here was a new field of activity for our fighters.

Plate 4. Hurricanes in the Middle East

Chapter 6

THE FIGHTERS' FUTURE

Earlier in this discourse I have said that our fighters must be the spear-head of our attack when we invade Germany, and that for an army to land on a hostile coast its co-operating air force must have complete command of the air over it. That briefly is the job of our fighters next year or the year after. They must be, in fact, the spear-head of victory in any war.

Intense bombing, and consequent breaking up of communications and supply-lines, may reduce a country to despair, or revolution or surrender. But the only thing that keeps a war won is a soldier on his flat feet, or on a horse, or in an armoured car, with a gun in his hand. And that soldier cannot get into that foreign country unless he is protected against enemy bombing.

So long as the enemy can bomb our troops when landing and when laying out supply bases, or can prevent the R.A.F. from using aerodromes to step forward its attacks on the enemy country, we cannot get a firm foothold in Germany—or, as a wag put it, we cannot do Dunkirk in reverse.

Therefore before we can start invading we must have fighters that can fly at least 150 miles into enemy-occupied territory and stay there patrolling and fighting for at least three hours. Our present fighters could do the journey, but they do not carry enough fuel to do worth-while work while there.

Also the new fighters must carry enough ammunition to do a lot of fighting. Some readers may be surprised, or even shocked, to learn that our present fighters only carry enough ammunition for about forty seconds of continuous firing.

Actually, if one fired a modern gun for a minute without stopping one would probably burn out the barrel. These guns fire at a rate of 1,200 shots per minute. Eight guns means 9,600 cartridges, and that means a lot of weight, even with ·303-inch rifle cartridges.

The shells for the 20 mm. (25-mm. = 1 inch) air-cannons naturally weigh a lot more. And the solid 20-mm. bullet fired from the long French Hispaño-Suiza gun, which many air-fighters favour, is heavier still.

The 20-mm. shell does a lot of damage if it hits the right place, such as a petrol-tank or control-gear, but it splinters into curious bits just like steel toe-nails. I have seen the intake pipe of one cylinder of a radial motor which was hit by such a shell, and laid open as if by a tin-opener, but the engine went on running, with a bit too much air for that cylinder. A solid bullet would have knocked off the cylinder-head, or at least the valve-casing.

In America for two or three years past the armament people have been boosting a 37-mm. (1½ in.) air-cannon. It has a length of recoil which could only be taken up in a big aeroplane, and so, if we are going to use heavier guns in the air, we shall obviously need heavier fighter aeroplanes.

The hydraulic gun-turrets invented by Captain Archie Frazer-Nash and the electric turrets of Boulton-Paul Ltd. have shown the value of concentrated fire, whether axial or transverse—that is, along the fore-and-aft line of the machine, or broadside.

All of which may help readers to visualize the long-range fighters of the future. It suggests something about the size of

a Vickers Wellington with a speed of more than 400 m.p.h. They will indeed be the heavy cavalry of the air.

But the high-speed thoroughbred, descendants of the Hurricane and Spitfire, will still be needed for closer fighting, just as our fast battle-cruisers need still faster destroyers. So the single-seat fighters may soon make a habit of beating Germany's world's speed record of 469 m.p.h.

Naturally one must not say what we have coming along in the way of fighters. Before war was declared, in July 1939 a privileged party of M.P.s, as guests of the R.A.F. at Northolt, were treated to a glimpse of two unnamed twin-motor fighters, which flashed across the aerodrome from nowhere to nowhere. A lot of keen foreign observers, uninvited, saw them from Western Avenue, which borders the aerodrome. So the observant of the world must have had an idea then of the lines along which we were thinking.

Among the things that will not alter are (*a*) the ability of designers of aeroplanes in this country to beat the world, if those set in authority over them give them a chance, and (*b*) the ability of our fighter pilots to knock the stuffing out of any enemy who may present himself, if the technical people in the Air Ministry will give them the weapons they want.

The job of the people of this country, by way of their Members of Parliament, and the job of the Press, which often represents the people better than do their M.P.s, is to see that they get those weapons.

Chapter 7

FLEET FIGHTERS

There is another category of fighter besides the land-going fighters which deserves notice, though we have heard little of it, that is the shipboard fighter—officially so called—or, more familiarly, the deck-flying fighters of the Fleet Air Arm.

The first sea-going or ship-borne fighters in history were the little Sopwith Tabloids on floats, known in the Navy and R.N.A.S. as the Sopwith Schneider type—because the first of them won the Schneider Trophy in 1914—but they were not deck-fliers.

Variants of them and of the Bristol Bullets and Sopwith Pups were flown off the decks of the primitive aircraft-carriers of 1914–18. And a Sopwith Pup, flown off a flat-bottomed barge towed by a destroyer, brought down a Zeppelin in 1918.

In the late 1920's and early 1930's deck-fliers were developed seriously, but they were always variants of land-going fighters. Thus the Hawker Fury single-seat biplane, which appeared in 1930, became the Nimrod, when equipped with slings for the Navy's derricks, and the Fairey Firefly single-seat biplane, similarly equipped, was built in 1931 primarily as a ship-board fighter, and was only used as a land-going fighter by the Belgian Army.

The Hawker Hart two-seat biplane, originally a general reconnaissance machine, was slightly modified to give the

aft gunner more scope, and became the Hawker Demon two-seat fighter. These machines are still much used at Advanced Training Schools in teaching aft gunners how to shoot. And the earliest Frazer-Nash power-operated gun-turrets were tried out in the Demons.

In 1930 Demons were fitted with slings for use with derricks, catapult points to fit the launching-carriages on the catapults of warships, and floatation gear in case of descents in water. With these alterations the Demon was known as the Osprey.

After that, and not long before war was declared, a number of Gloster Gladiators were similarly fitted for naval use and became Sea-Gladiators.

At first all these deck-fighters were supposed to pull up on the deck of an aircraft-carrier by using their brakes, but a smooth, holy-stoned deck gives so little grip for wheels, and so many of the deck-landers trickled over the side into the protective fence that is put up while aeroplanes are 'landing-on', as it is called officially, that the Navy decided to go back to the arrester-wires, which are the most primitive and yet the best way of stopping an aeroplane—especially when it has to land in a narrow space.

These arrester-wires are stretched across the deck, and the ends are wound round drums, which allow them to unwind against a spring when pulled. The aeroplanes carry a hook, in front of the tail-wheel, or skid, which is let down when about to alight. The wheels of the aeroplane roll over the wires, which are held only a couple of inches above the deck, and the tail-hook catches the first wire it reaches and collects others as it runs forward, so that the pull on it is gradually but quickly increased, and the machine is brought to a standstill.

All these gadgets necessarily mean increasing the weight of the machines, and so the performances of Fleet Fighters are

naturally not so high as those of corresponding landplanes. But they are quite good enough to tackle ship-borne bombers and reconnaissance craft, and float-planes and flying-boats, which are their lawful prey.

After the Sea-Gladiator came the Fairey Fulmar, the Navy's first monoplane fighter.

The genealogies of the Nimrod, Osprey, Gladiator, and Fulmar will be found in the chapters on the Hawker, Gloster, and Fairey firms. This book is concerned with fighters only, so there is no place in it for the magnificent work of the Royal Naval Air Service of the past, or of the Fleet Air Arm to-day. That would need a book to itself.

PART II

ARMAMENT AND ARMOUR

Chapter 8

ARMAMENT DURING THE WAR OF 1914-18

Armament in aeroplanes has, naturally, almost as long a history as have the aeroplanes themselves. The first attempt at arming an aeroplane was demonstrated at Bisley in about 1912, when Mr. Claude Grahame-White, piloting a box-kite biplane, took up Mr. Marcus Manton, sitting in a kind of bucket-seat among the undercarriage struts, from which uncomfortable perch he fired a Lewis gun. I do not remember that any particular attention was paid to whether he hit a target or not. The point was that a machine-gun had been fired from an aeroplane.

Thereafter, only a little while before the outbreak of war in 1914, the Vickers firm at Brooklands produced a pusher biplane that carried a machine-gun in the nose. It was called the Vickers Gun-Bus, but when war broke out it was still very much an experiment and none were used in squadrons overseas—so far as I know.

The result was that the Royal Naval Air Service and the Royal Flying Corps alike went to war completely unarmed. And this in spite of the fact that a naval officer, Lieutenant Clark-Hall, now Air-Marshal Sir Robert Clark-Hall (retired), residing in New Zealand, had during 1914 actually fired a two-pounder gun while perched up in the nose of a

Short pusher float-plane. The machine had a 200 h.p. Canton-Unné (Salmson) motor, which was colossal for those days, but when the gun was fired the machine practically stood still in the air. And that, please mark, was the beginning of the 'air-cannon', to which we are gradually coming twenty-six years later.

I believe that the first authentic instance of an aeroplane being forced down by fire from another in war was when Lieutenant Fenton Vesey Holt (Oxon. and Bucks. Light Infantry and R.F.C.), flying a Martinside single-seater, attacked a German two-seater with a revolver, either late in 1914 or early in 1915. There is no record whether he hit the machine, or whether the mere waving of a revolver from a fast single-seater (fully 85 m.p.h.), circling over the German reconnaissance machine, was enough to intimidate the pilot into landing.

Thereafter, as the majority of our aeroplanes were of the B.E.2c tractor biplane type, which afterwards became known as 'Fokker Fodder', and carried the passenger in front between the planes, while the pilot sat aft, there was no possibility of arming them. But some gallant passengers used to carry a rifle, which they fired sideways over or under the airscrew, or backwards over or beside the pilot's head if opportunity served.

This kind of thing went on for some months, and still there was no sign of Vickers Gun-Buses in quantities, or even of Farman pusher biplanes with guns in the nose.

The French did a good deal of experimenting in that way. One clever French pilot mounted in the nose of a pusher one of those penetrating motor-car headlights that used to illuminate the long straight roads of France quite clearly half a mile ahead. Above it he fixed a machine-gun. Experimentally he patrolled a certain road looking for a certain car, which, according to reports at the time, he identified. And that, I

fancy, was the beginning of an idea for the defeat of night raiders. But it may have been intended only for the spotting and machine-gunning of convoys on the roads at night.

Such use of flying search-lights might have been all right in those days, but to-day the drawback is that light anti-aircraft guns such as the Bofors would simply shoot at the base of the beam and probably get the aeroplane every time. Something more scientifically developed is needed in these days.

About the next development in armament was that with which that gallant little sportsman Roland Garros experimented. Everybody had the idea that if one could only fix a machine-gun to fire straight ahead from a single-seater one could do quite good business. But, obviously, guns that would be reachable from the pilot's seat would have to fire through the circle in which the airscrew was revolving (at about 1,200 r.p.m.) and so some of the gun's 300 shots per minute would be bound to hit one blade or other of the screw. Some of our R.N.A.S. tried it and punched holes in the blades, fortunately seldom breaking a blade—which might have wrecked the machine.

So far nobody had devised an interrupter gear to stop the machine-gun from firing as the blades of the airscrew passed the muzzle of the gun, nor had anybody thought of a synchronizing gear to fire the gun when the blades of the airscrew were not there.

What Garros did was to fit a bit of armour plate to each blade of his airscrew in a little Morane monoplane, just at such a radius from the centre of the motor that if a bullet were fired at the fraction of a second when the blade of the screw was in front of the muzzle of the gun, it would hit the bit of armour plate and would be deflected without hurting the screw.

That scheme worked quite well, but the two bits of armour plate added to the weight of the screw, and as they had to be set at an angle so that they should deflect the bullets they added very much to the drag of the screw and absorbed quite a lot of power—of which all aeroplanes were very short in those days.

Then came the era of interrupter gears and synchronizing gears. Constantinesco invented an interrupter gear that worked hydraulically and prevented the gun from firing as the blade passed. And Kauper, at Brooklands invented a synchronizing gear that fired the gun at the right fraction of a second.

Just about the same time, in Germany, Anthony Fokker, a young Netherlander who had been taken up by the German aeronautical authorities before the war, and was by that time making a cheap but effective copy of the French Morane monoplane, also invented a synchronizing gear. His description of how he invented it and what he did with it in the experimental stages appears in his autobiography, *Flying Dutchman*. It is one of the most amusing books and one of the most informative on early air war that has been written.

That began the era of proper machine-gun fighting.

Our poor old B.E.2c's doing artillery observation and general reconnaissance used to fly up and down right over the fighting line, and the Fokkers used to dive on them and shoot them down like chickens. Our French Moranes and Sopwith Pups, with synchronizing gear, did quite good work when they could get near the German reconnaissance machines, but the Germans seldom came far enough over our lines to give our people a chance of getting at them.

We were using the old B.E.2c's also as bombers. They went quite a long way behind the enemy lines, and so our losses were far heavier than those of the Germans.

The result was the scandal of the Fokker Scourge in 1915 and the beginning of 1916, followed by the Air Inquiry Committee of May 1916, as the result of which an Air Board was created by the Government. And at the end of 1917 the Air Board was made an Air Ministry, which began operations at the beginning of 1918.

Chapter 9

REFORMING THE FLYING CORPS

The Fokker Scourge was the basis on which Lord Montagu of Beaulieu, Mr. Joynson Hicks (later Lord Brentford), and Colonel Faber, M.P., based the charge, first made by Colonel Faber, that our people were being murdered by official negligence rather than killed by the enemy. Squadron Commander Noel Pemberton Billing, then an officer in the Royal Naval Air Service, was allowed to resign his commission and enter Parliament as Member for Hertford, and became the leader of the agitation.

While the political agitation was actually in progress the Sopwith Company were experimenting with a machine that caused a minor revolution in air war and in armament. It was a biplane which, because of a curious arrangement of the interplane struts, was always known as the '1½-Strutter'. A cumbersome title, which became so familiar that at last it came easily off the tongue. Sometimes it was abbreviated to the 'Strutter'.

This was the first aeroplane in which the pilot had a synchronized gun in front and the passenger sat behind him with a Lewis gun, at first on a swivel mounting, and later on what was called a Scarff ring. In this arrangement the gunner sat, and when in action stood, in the middle of the ring and was able to run the gun all round the rail that formed the ring, rotating himself in the centre.

The innocent German fighter pilots, we used to call them scouts in those days, used to leap down out of the sky on to the tail of the two-seater, thinking that it was just another B.E.2c to be massacred, and found themselves blown out of the air by a burst of fire from a Lewis gun. The effect at that time was as demoralizing to the Germans and as heartening to our people as was the introduction of the Frazer-Nash hydraulically operated four-gun turret in our big bombers in this war, and as the unexpected advent of the Defiant with its four-gun Boulton-Paul turret firing broadsides into the German dive-bombers during the rescue of the British Army at Dunkirk.

The first squadrons of the 1½-Strutters appeared during the Battle of the Somme in 1916, when the R.F.C. was having a terribly bad time. All the various types of Sopwith machines had been built to the order of the R.N.A.S., because, while the Army Air Department insisted on standardizing on the wretched B.E.2c, the policy of the Admiralty Air Department, under Captain (later Commodore) Murray Sueter, had been to encourage aircraft constructors to build new and improved types of their own design. So the Admiralty lent an R.N.A.S. squadron of 1½-Strutters to the Army, and allowed the Army to have enough 1½-Strutters to equip two or three squadrons of their own.

At last the War Office was convinced of the folly of standardizing on officially designed aeroplanes, and thereafter followed the Navy's policy of encouraging the aircraft industry to produce new ideas. And that was really how we won the command of the air at the end of 1917 and held it throughout 1918 until the Armistice. And I am not making too big a claim when I say that we won the war on the ground because we won the war in the air.

In his dispatch dated 23rd of December 1917 the General Sir Douglas Haig, commanding the British Expeditionary

Force in France, said: 'I desire to point out that the maintenance of the mastery in the air, which is essential, entails a constant and liberal supply of the most up-to-date machines, without which even the most skilful pilot cannot succeed.' Further on in the same dispatch, he said: 'Fighting in the air has now become a normal procedure in order to maintain the mastery over the enemy air service.'

That fighting in the air necessarily meant the development of armament. And those same remarks are just as true to-day as they were twenty-three years ago.

The first 1½-Strutters had a single synchronized gun in front. The pilot aimed it by aiming the machine, just as modern guns are aimed, by manœuvring the whole aeroplane. And the gunner aft also had a single gun. Later two guns were fitted forward and two guns were fitted on twin mountings aft. These again gave the Germans an unpleasant surprise.

Parallel with this development was the development of the 'pusher' biplanes. Captain Geoffrey de Havilland, from whom the great De Havilland Aircraft firm to-day takes its name—he is, happily, still a director—had designed for Mr. Holt Thomas's Aircraft Manufacturing Co. Ltd. the D.H.2, a little single-seat pusher, which had a *monosoupape* or 'single-valve' Gnôme rotary motor. It had a single Lewis gun in the nose. The gun could be locked and aimed by manœuvring the aeroplane, or it could be unlocked and moved about on a swivel, so that it could fire up or down or sideways.

Incidentally, I know one Australian pilot who saved his life, when being pursued by one of the German star turns, by throwing his machine on to one wing-tip, doing a terrifically tight vertical bank, which brought him round inside his pursuer, and giving him a burst of fire across the arc of the circle in which he was turning—which meant firing verti-

cally upwards, so far as the attitude of the machine was concerned, though in fact it was actually horizontal.

Those little D.H.2's were amazing little machines, and if only they had been faster they would have been deadly fighters. The trouble was that they could never be so fast as the German fighters with tractor screws and interrupter gears, because there were no engines big enough to put in them, and furthermore they were a mass of tail booms and wires.

An interesting point is that the Germans have been, during 1939 and 1940, experimenting with a monoplane pusher.

The reason why these machines with this form of armament were not a success was that although the Germans could hardly ever bring them down, because of their manœuvrability, they were easy meat for the German fighters if they straightened out and tried to get home. The result was that they used to circle round and round, keeping out of the way of the Germans, but, as there was always a west wind blowing, they just drifted farther and farther over occupied territory, till they ran out of petrol and had to land.

Shortly before the outbreak of war in 1914, the Royal Aircraft Factory at Farnborough had been experimenting with pusher biplanes, which were known as the F.E. type. The initials stood for 'Farman Experimental', because the Farman Brothers in France had made the first, or at any rate, the most important, pusher biplanes. The factory produced first of all the F.E.2—the F.E.1 was of no particular account, and the first of the type that went into action was the F.E.2b, which had a Beardmore six-cylinder-in-line water-cooled motor. The nose of the machine was shaped rather like a pulpit, and it carried at first a single Lewis gun and later twin Lewis guns, which covered very nearly the hemisphere in front of the machine.

It was terribly slow, but was very self-defensive. Like all

the old pusher biplanes, it could stand on one wing-tip and go round and round, so that the enemy could never get his guns on it. And because it had a gunner separate from the pilot, it was able to do better shooting.

The obvious disadvantage of the type was that if a fast enemy machine got behind it the gunner could not shoot him down, as could the back gunner in the Sopwith 1½-Strutter. The best he could do was to stand up, unship his guns, and fire over the top of the airscrew.

All the same, the F.E.2b did considerable execution because the Germans used to mistake it for an innocent Farman with a single gun in front.

Right up to the end of the war the F.E.2b was used for night bombing. Those night bombers in that type of machine deserve a book to themselves, which they have never had and are never likely to get. Think of sitting in the nose of an aeroplane landing in the dark, with the knowledge that if you made a mistake the machine would turn over on top of you and you would get the big engine in the back of your neck. For some curious reason, when the machine did crash on landing, the pilot and gunner were generally catapulted out of their seats and came down in front of the machine, or rather behind it, because the machine would then be lying on its back with the tail in the direction in which it had been going.

But that has nothing to do with armament. In 1918 a still bigger version of the F.E.2, which was known as the F.E.2d, appeared. It had a Rolls-Royce Eagle 12-cylinder Vee motor of about 450 h.p., which by sheer brute force pushed the machine through the air so fast that it was nearly as fast as the German reconnaissance machines.

That was about as far as the pusher type ever got during the war, chiefly because there was no way in which they could be defended aft, whereas the tractor biplanes could shoot both ways.

We may now return to the tractor machines. By 1917 the Royal Aircraft Factory had turned out a fairly satisfactory version of the R.E. (Reconnaissance Experimental) tractor biplane. But up till the end of 1917 it was still regarded with deep suspicion. The armament was copied from the 1½-Strutter. It had a Scarff ring with twin Lewis guns aft, and in front it carried two belt-fed Vickers guns.

At Easter 1917, as mentioned earlier in this book, the famous Bristol Fighter appeared for the first time. As with all our new types it had a disastrous beginning, when we presented all but two of a full squadron to the enemy on Good Friday. But during the rest of 1917 and 1918 it was one of the very great fighting aeroplanes of the war. It also had synchronized twin Vickers guns in front, and twin Lewis guns, which carried their cartridges in drums, in the aft cockpit. The difference between the Bristol and the other two-seat fighters was that the pilot and gunner practically sat back to back, in touch with one another, whereas in the R.E.8 and in the 1½-Strutter there was an interval or deck, only a matter of a foot or so but still enough to give the gunner a certain feeling of isolation.

Among the single-seaters, twin guns firing through the airscrew were almost universal. About the only exception was the little Nieuport biplane, which, besides a Vickers gun forward, carried a Lewis gun mounted on the back spar of the upper plane above and in front of the pilot, so that if the chance offered he could aim it at an aeroplane flying above him.

Some pilots used to specialize in that method of attack. Instead of climbing up after an enemy and trying to get on his tail, they would sit below him and fire up at him. That was a scheme that worked quite well, because, until late in the war, the Germans had no machine from which the pilot could fire downwards through the floor.

Chapter 10

ABOUT GUNS

Throughout 1914–18 there was hardly any alteration in the actual guns themselves. The Vickers belt-fed gun and the Lewis drum-fed gun were virtually the same at the finish as they were at the start. They fired faster and improvements were made in detail, but the principle remained the same. The rate of fire went up from somewhere about 200 or 250 shots per minute at the beginning of the war to something around 600 shots per minute at the end of the war.

But during 1917 and 1918 there was an interesting development, which was the beginning of what we now call the cannon-gun. The Swiss Oerlikon firm, which had made machine-guns for a long time, produced a gun of about ½ inch, or 13 mm., calibre. The Hispaño-Suiza Company, makers of the famous French racing cars, who by 1917 were making a very good Vee-type aeromotor, struck the brilliant idea of making the camshaft, which drove the valve mechanism of both blocks of cylinders, and naturally lay in the middle of the Vee between the cylinder-blocks, of such a size that a gun-barrel could be built into it.

The gun fired 20-mm. (roughly ⅘-inch) shells that were intended to burst on contact, and often did so. They then mounted the airscrew on the big camshaft instead of on the main shaft of the engine, so that the gun could fire along the camshaft and out through the hub of the airscrew. They

called it, and still call it, the *moteur-canon*. It was a beautiful idea and it worked.

According to the legends of the French Service d'Aviation the Hispaño-Suiza Company built four such motors in which the gun was an integral part of the motor. They probably built a lot more, but at any rate three *moteurs-canon* were issued to three of the crack French fighter pilots, Guynemer, Nungesser, and René Fonck. The story at the end of the war was that Guynemer had fired three shots from his *canon*. Each of the first two brought down an enemy aeroplane, but at the third shot the breech blew out of the gun and removed one side of his face. What happened to Nungesser's gun never became public property: he probably did quite well with it, because he was a good fighting pilot. Fonck used his gun regularly during the last few months of the war, and brought down a number of German aeroplanes.

The pity is that after the war he did not turn his undoubted ability to improving the armament of warplanes. Instead of that he became a member of the Chamber of Deputies and quite an effective politician.

MODERN ARMAMENT

Since 1918 the development of armament for aircraft has been slow, but quite reasonably effective.

The Lewis gun, though it has done good service for more than twenty years, has taken very much of a back seat as flying armament for aeroplanes. By the nature of its mechanism it cannot whack up the colossal rate of fire that is now habitual.

The gun used by all our attack machines, or single-seat fighters, as we call them, is an anglicized version of the American Browning. Some of my older readers will remember that in the days of our youth we used to hear about Browning pistols, which rivalled the Colt as the weapon of

the bad men of the Wild West. In fact, I think the Browning automatic replaced the old Colt ·45 revolver in such romances. Then the Colt people retaliated by bringing out an automatic pistol of their own.

I am not enough of an armament expert to know when the Browning machine-gun was developed, but a point of real interest to us is that those which are used in our aeroplanes to-day fire 1,200 shots a minute. That is about four times the rate of fire of those used in 1915–16.

Another gun in high favour among the R.A.F. gunners is the Vickers K gun. Unfortunately there is no room in this book in which to describe in detail the differences between a gas-operated gun and a mechanically operated gun, nor to discuss all the niceties of the mechanism.

The most striking alteration in fighting aeroplanes in this war compared with those of the last war is the increased fire-power.. During the twenty years between the two wars the armament specialists of the air forces of the world have been arguing this question. Most people know that our modern fighter monoplanes carry eight ·303 guns, four inside each wing, firing outside the radius of the airscrew, so that we are free of the complication of interrupter and synchronizing gears.

There are pilots who are by nature first-class shots who argue that a single machine-gun of ½ inch calibre (13 mm.) would suit them better than four or six or eight guns firing ordinary rifle ammunition of ·303 inches diameter, or roughly 8 mm. But the ordinary pilot definitely prefers a whole lot of machine-guns with which he can pump bullets into his enemy like water from a hose, rather than that he should have to depend on his own accuracy of shooting for his effect.

These arguments have produced a great variety of guns and ammunition. Since the last war the cannon-gun has been much developed from the original ⅘-inch (or 20-mm.) *mo-*

teur-canon, and no longer fires through the motor. And the ½-inch gun now fires solid bullets, which have terrific smashing power, about as fast as the old Lewis and Vickers used to fire ·303 bullets.

An interesting point is that the most popular ·5 gun in the U.S.A. is the Colt. So now we see revived the years-back rivalry of the heavy-calibre Colt and the small-bore Browning automatic pistol.

On the whole, the 20-mm. shell has been rather disappointing as a projectile. If it hits a human being and bursts it almost certainly kills him, though it might with luck blow his arm off and his life might be saved by quick surgical action. But I have seen aeroplanes in which 20-mm. shells have burst with surprisingly little effect.

One of them was a medium bomber. The aft gunner was killed by a cannon shell that struck him in the chest. But another cannon shell burst right in the middle of the cabin and the radio operator said that all he saw was a blinding flash. The tiny splinters from the shell travelled on and had wounded both the pilot and the navigator, but very slightly. Another cannon shell, as described in an earlier chapter, had gone through the cowling of the motor. Another shell had burst in the extreme tip of the tail of the fuselage, where is the cross-member on which the elevator lever operates. All the shell had done was to make a few dents in the levers.

Some of the armament experts would prefer to have 20-mm. solid bullets, because they say that their smashing power would do more harm than is done by a bursting 20-mm. shell. But now a 37-mm. gun (practically 1½-inch bore) is coming along after development in the United States. Several samples at the Brussels Aero Show in July 1939 attracted much attention from German and French and British Air Force officers.

The obvious difficulty about and objection to the 37-mm. gun is that it has a terrific recoil, which can only be taken up by allowing the barrel a long travel.

That is not difficult to arrange when the gun is fixed in the fuselage of a twin-motor fighter, where it has all the inertia of two big engines to take up the kick, and most of the length of the fuselage for the recoil. But to design a turret that will swivel and will take the recoil of such a big gun at an angle to the path of the machine is definitely a big engineering job.

Also we have to remember that these big guns, whether the 13-mm. or 20-mm. guns firing solid bullets, or the 37-mm. gun firing shell, cannot fire anything like as fast as the rifle calibre (·303) gun, and so the shooting has to be much more accurate.

Moreover, in spite of the fact that the ·303 guns firing 1,200 shots a minute each mop up such a colossal weight of ammunition in a few seconds that until lately they could only carry ammunition equivalent to about thirty or forty seconds of continuous firing, the weight of the ammunition for the cannon-guns is very much higher, although they fire much more slowly. So we must just wait and see what our new fighters are like.

The one thing that is evident is that the pilot who is a good shot with a long-range cannon will always have the advantage over the man who is armed with ·303 ammunition. Provided that the machine which is carrying the cannon is a little faster than the other, the pilot of the cannon-carrier can always keep out of range of the ·303 man and can just sit around and take a pot at him at his leisure.

On the other hand, if the pilot of the multi-gun ·303 fighter can get within range of the machine with the heavy gun, he has the advantage that there is no need for him to shoot very accurately. He can simply overwhelm his adversary by fire power. The position is rather that of our light cruisers, with

many small guns, which overwhelmed the *Graf von Spee* in spite of its heavier guns.

Fortunately pilots generally like best what they know best. A fighter pilot said to me recently, 'Well, they can have their cannon, but, believe me, a self-sealing petrol-tank does not keep a wing really *firmly* in place after a bunch of ·303's have sawed through the spars.'

Chapter 11

ARMOUR AND ARCHIES

Another subject now comes into the discussion; that is, the amount of armour that a fighting aeroplane can carry.

When we went into this war, so far as I remember, there was no attempt at making windscreens bullet-proof, although we had read much of bullet-proof glass in the cars of gangsters in the United States. The idea that aeroplanes would attack one another head-on was not commonly accepted and the prospect of being hit in the wind-screen by a bullet from an aft gun-position did not seem to worry anybody. Archie Nash's four-gun turrets were not known in those happy days.

I confess to being somewhat puzzled about what precisely decides, when two aeroplanes are firing at one another head-on, which of them turns in which direction and which in the other to avoid a collision. If instead of sticking to the 'rule of the road' in the air, that is keeping the other fellow on your left, as at sea, one pilot chooses to rush over to the left side of the sky just when the other turns to his right, a collision would seem probable. And which turns away first seems to be largely a matter of who has the most nerve.

Also both sides started this war without any particular fixed theories about armour. By the end of 1940 the pilots on both sides were encased in bullet-proof armour almost to

the degree customary among our ancestors of the fourteenth and fifteenth centuries.

The modern German single-seat fighter pilot has a sheet of armour all up his back practically to the roof of his cabin, and there it curves forward so that it protects his head and a good deal of his shoulders. Also the floor is armoured to protect him against attack by enemy machines diving from above him and pulling up vertically underneath and giving his machine bursts in the belly. Likewise the motor itself is armoured, for a dozen or more bullets sculling around inside a crank-case are not good for any motor.

I remember well in the last war that a friend of mine who commanded a squadron of artillery-observation machines, which were always being shot up from below, because they kept as low as they dared over the fighting line, discovered that the armour-plating on German machine-guns in their strong-points was very effective. Consequently, whenever our infantry made an advance he used to send a party of his air-mechanics along behind the infantry, ostensibly to look for crashed aeroplanes, but really to hunt for German bullet-proof plates. When they were brought back to the squadron, the squadron armourers with much difficulty used to cut them to fit the seats of the aeroplanes, so that at any rate the pilot's body was protected from machine-gun or rifle attacks from below.

This worked beautifully until one day a big general came along, and when the squadron commander showed him with pride the bullet-proof seats, ordered that they should all be taken out. The reason he gave was that if the other squadrons discovered that this squadron had bullet-proof seats, they would all want them, and that the British Army was not advancing fast enough to secure German bullet-proof plate for all the squadrons. Consequently, there would be jealousy and discontent.

It seemed a hard decision, but on consideration the squadron commander agreed with it. Anyhow, he had to take the seats out.

To-day the scheme is to armour everything as much as the machine will lift.

THE GROUND-STRAFERS

There is one form of aeroplane, definitely a fighting machine, which has been completely neglected since the last war—and one which has its own problems in armament and armour. Almost every fighting pilot I have met since this war began agrees that the genuine ground-strafer, designed expressly for that purpose, will be much needed.

During 1918 the Sopwith Company, as always in the front line of development, built a quaint tractor biplane which they called the Salamander.

The allusion, naturally, was to the fact that a salamander is popularly supposed to be able to live in a fire without being burned to death. The function of the Salamander was to fly so low over enemy trenches or over roads or country occupied by the enemy, that it would be able to punish enemy troops severely with machine-gun fire, while it would itself stand a good chance of getting through with nothing worse than a few holes where they did not matter.

The whole belly of this machine was armoured, underneath the motor, underneath the tanks, and underneath where the pilot and the gunner sat. The gunner fired downwards through the belly of the machine at the road or trenches or whatever his target was supposed to be. If I recollect rightly, the Salamander had either six or eight guns firing downwards.

At about the same time Dr. Junkers in Germany designed the Junkers ground-strafer. It was a low-wing monoplane of which the fuselage, or hull, and the wings were built of corru-

gated aluminium on the same lines as the machines the firm later made for civil aviation. And, being German and very thorough, Dr. Junkers arranged for the ground-strafing to be particularly deadly.

The machine carried sixteen machine-guns arranged in four banks of four, all pointing through the bottom of the fuselage. The pilot, as the guns were fixed, also controlled the aim of the guns. The function of the man inside was merely to keep on loading the guns.

Whether the guns were arranged so that the pilot could, by pressing a button, fire all sixteen at once, or whether he was limited to firing four guns, then another four, then another four, and then another four, I do not know. But presumably, in attacking troops in trenches or along a road, the pilot would in fact fire his four front guns till he used up all his ammunition, and would then use up the ammunition in the second, third, and fourth, bank of guns. Possibly he might vary the performance by giving a burst of fire from No. 1 bank, and then a burst from No. 2, then a burst from No. 3, and then a burst from No. 4, so that the guns in each bank did not overheat and strip their rifling by continuing to fire at top speed for too long.

The obvious disadvantage about ground-strafing with an aeroplane of that sort was, and is, that if it should fly straight and level along a road or a railway, or a trenchline, people on the ground can see it coming, and can either get out of the way, or stand and shoot at it. A machine flying straight along a road obviously going for a bridge packed with troops would stand a good chance of being brought down by flying into a barrage of machine-gun fire put up in front of it.

Nevertheless, an aeroplane of that sort with armament properly arranged ought to be far more effective than any attempt at ground-strafing with multi-gun fighters. The ordinary fighter, whether it has two guns or eight or a dozen guns

in front, can only fire in a straight line parallel with the fore-and-aft axis of the aeroplane. When the pilot starts his dive, the bullets plunge almost vertically into the earth. As he pulls out of a dive, they will hit at a more and more acute angle to the ground, so that conceivably, when the pilot is almost at the bottom of his dive, the bullets might go through two men, one after the other.

As soon as the pilot has reached a horizontal position and is beginning to zoom upwards, then his bullets either fly across country or go up into the air. So, in effect, attacks by normal fixed-gun fighters on troops on the ground are, so to speak, tangential. That is to say, they are only reasonably effective while the aeroplane is performing one quarter of the circumference of a circle.

Advocates of the other method, namely, of having a number of guns pointing through the floor of the machine, say that by jinking and dodging, and diving slightly and zooming slightly, a good pilot in a real ground-strafer of either the Salamander or Junkers type can do much more business.

ARCHIE-GUNS AND FLAK

No doubt we shall in due course, before the war is over, come across new things in armament. As we are discussing fighter aeroplanes, this is not the place in which to deal with anti-aircraft guns, although they are the friends and the enemies of fighter aeroplanes, according to the side to which they belong. But possibly, as it has to do directly with aeroplanes, I may interpolate here a short explanation of why anti-aircraft guns are so commonly known as 'Archies'. In the very early days of the War of 1914–18, when, in Germany at any rate, anti-aircraft guns were far more highly developed than the aeroplanes themselves, one of our B.E.2c biplanes was out on reconnaissance piloted by Lieutenant Amyas Borton then and now commonly known among his friends

as 'Biffy', and now Air Vice-Marshal A. E. Borton, C.B., C.M.G., D.S.O., A.F.C., after a distinguished career in the R.F.C and R.A.F. With him was Lieutenant Rabagliati, who retired after the war as Lieutenant-Colonel, D.S.O., etc. As they reconnoitred around, the German anti-aircraft guns kept on shooting at them without hitting them.

At that time there was a popular music-hall song in London, the refrain of which was 'Archibald, certainly not'. And whenever an A.A. shell burst uncomfortably near the machine, Mr. Borton would jerk it round on a different course and remark down the speaking-tube to his observer, 'Archibald, certainly not.' When they came down, Rabagliati told the story to the Mess, and from that day onwards anti-aircraft guns have always been known as Archies. It happens to fit in with the official initials, A.A. guns, which possibly has perpetuated the habit.

At present the tendency in the R.A.F. is rather to adopt the word 'Flak', which is the official word for the Anti-Aircraft Artillery. The Flak is part and parcel of the Luftwaffe. The word is made up of the initials of *Flieger Abwehr Kanone* —or flier-down-shooting-canon.

RAY ARMAMENT

No doubt in time armament will include many things about which we know nothing at present. I am no believer in the much publicized 'Death Ray', but I do believe that a good deal can be done with rays of one sort or another in connection with armament. For many years American experimenters have been trying to produce an altimeter, or height-measurer, that will show the exact height of an aeroplane above the ground. The ordinary barometric altimeter only gives the height above sea-level at the particular atmospheric pressure that existed when and where the machine started. A few hundreds of miles away variation of pressure

may throw the measurement a thousand feet out, and the ground over which it is flying may be 20,000 feet higher than the starting-place, without the pilot knowing it.

The American experiments were made with what was called an echo ray. A ray was projected downwards, hit the earth, and an echoing ray bounced back again. The time between the emission of the ray and its reception on a delicate measuring apparatus gives the distance from the machine to the earth.

There are always possibilities that such echo rays, or bouncing rays, might be used to locate the exact position of enemy aeroplanes, either for guns on the ground or for fighters in the air.

Some fifteen years ago I suggested to the radio experts of the world that they should invent some means by which an aeroplane could progress in a sort of aura of radio waves, which when they impinged on the receiving apparatus in another aeroplane would indicate the direction and the approximate distance of the emitting machine. Every aeroplane would be by law equipped with emitting and receiving apparatus, and consequently every aeroplane would, either in darkness or in cloud, know of the neighbourhood, direction, and approximate distance of any other aeroplane. Naturally the distance would have to be limited, otherwise one would be told by one's apparatus when flying over London of the presence of a machine over Dublin or Berlin. Which would be unnecessary.

Dr. Lewis, the Chief of the U.S. Government's Aeronautical Experimental Establishment, told me a year or two later that experiments were being made in that direction. But so far nothing has been evolved, and I am still waiting for my 'Radiaura'. Perhaps the spur of war will produce something which in time of peace can be turned to that use, and may prevent collisions in the air.

Chapter 12

NIGHT FIGHTING

This naturally brings one to the subject of night fighting. In the last war the problem was fairly simple. We had balloon aprons, not a complete balloon barrage, as at present, which, because we quite deliberately talked about it so much as a deadly secret, naturally impressed itself on the Germans so that their bombers over London at night never flew below 8,000 feet.

From 8,000 feet to 14,000 feet the gun barrage pretty well filled the sky. Whether it was bigger, better, or brighter than the gun barrage of this war, I do not pretend to say. But at any rate it was effective.

Above 14,000 feet, which was apparently the limit of the 3-inch guns of that time, we had our night-flying fighters. They were Sopwith Camels at first, and Sopwith Snipe with 250 h.p. Bentley rotary motors afterwards. These went up whenever enemy aeroplanes were reported over the coast, and they cruised around until either they saw a machine caught in the searchlights, or they saw a number of shells bursting in one part of the sky, which was generally taken as indicating that there were enemy aircraft in that direction. The searchlights in those days were very good.

The whole London Air Defence Area, known as Lada, was commanded by Major-General E. B. Ashmore, C.B., D.S.O. Aeroplanes, guns, and searchlights all came under him. As

he was a gunner officer who had done exceptionally well at Woolwich, and had been top of his years at the Staff College, he had an excellent grip of the whole thing. By March 1918 General Ashmore had convinced the Germans that raiding England was not worth while. And we never had any more trouble. May history repeat itself.

But even in those days, people were sceptical about the efficiency of our air defences. And there were instances in the East End of people mobbing innocent air mechanics of the R.A.F. and even throwing stones at them, saying, 'Why don't you go up in the sky and stop the night bombing?' When the poor lads had never been in an aeroplane in their lives and never had any hope of getting into one

Nevertheless, the bombing was stopped when the High Command had had time to develop technical weapons.

In this war the chief difference seems to be that modern bombers fly so high that the searchlights cannot reach them, and only the heavier guns can do so. Consequently, although we have first-class night pilots and aeroplanes that are well able to shoot down any of the enemy, the difficulty is to see them so that we can catch them and shoot them.

The problem was well put to a bar-room critic of the R.A.F. by a supporter of the Service. He asked the critic whether he had done any shooting. When he said yes, the other man said, 'Well, go into a dark room, get your youngest child to let loose a bluebottle fly, and then strike matches. When you've hit the bluebottle, come and tell us how you've done it, because we should rather like to know.'

That was the problem up till the end of 1940. Before then interesting developments were taking place, and I hope that by the time this book appears a lot more will be known about how to catch and shoot down night raiders.

The problem is to find the raider. When once he is found,

shooting him down becomes an ordinary air fight—albeit in the dark.

The most obvious method of finding the raider naturally is to send up aeroplanes and to sweep with searchlights those areas of sky that the Observer Corps on the ground have notified to Fighter Command R.A.F. as being infested with enemy aircraft, or to which enemy aircraft appear to be heading. But searchlights are only useful on clear nights and up to limited heights.

When an attack on a big city is in progress there should be less difficulty in spotting enemy machines, because the area over which one has to look for them is limited. But looking for them is not so much a matter of area as volume. The area of a big city may be only 100 square miles, but the enemy aircraft may be flying at any height between 1,000 feet and 30,000 feet, so that the fighter has to find a small aeroplane in 600 or 700 *cubic miles* of air. If there happen to be 200 aeroplanes in that 700 cubic miles within a limited time, there is more hope of spotting a few of them.

Many people have suggested carrying searchlights in our aeroplanes, but there are two objections. One is that if you stand directly behind a powerful searchlight, you can see nothing. You are blinded by the beam.

Most people know that even with the most modern searchlights, which have very parallel beams, the operator has to stand some distance out on a flank, working the machine with a long handle. In the last war, when the beam was more diffused, the operator saw nothing, but worked his beam 'Up, down, right, left', according to the telephoned orders of an observer a hundred yards or so out on a flank.

Obviously, therefore, a man sitting in an aeroplane right behind a searchlight would see nothing.

Another objection is that, even if a way could be devised of preventing the dazzling effect, the end of a searchlight

beam is obviously the place where the searchlight is. Therefore, any aeroplane that carried a searchlight would be quite promptly shot down by any enemy aeroplane that could get near enough. The searchlight-carrier might be sweeping the sky looking for enemy machines in front, and a fast enemy bomber might come round behind him and shoot him down without being seen. There would be nothing to indicate to the searchlight machine that an enemy was attacking from behind.

A more promising suggestion is that of sending up big bombers to a great height over towns that are likely to be attacked. When approaching enemy aeroplanes are signalled by radio from the ground, the machines high up should start dropping very big flares, which would light up the sky so that there would be a chance to see the enemy machines. Patrols of our fighters would be following the flare-carrier, and would, so to speak, 'dive out of the sun' on to the enemy.

The objection has been raised that such flares would light up the ground and disclose their targets to the enemy. The answer to that is that flares dropped at 30,000 feet would illuminate the ground very little. On the other hand, as there is almost always a ground mist in the winter, the flares would reflect back from the mist or low clouds, and the enemy machines would stand out in silhouette against the reflected light.

At the time of writing, early in the year, and leaving out secret methods of catching night raiders, which I happen to know are being developed, the flare-carrying patrol at great heights seems to be the most promising method of catching raiders—at any rate, that one can discuss in public.

PART III

THE PEDIGREES OF THE BRITISH FIGHTING AEROPLANES

INTRODUCTORY

In the first part of this book I have compared the British fighting aeroplanes, which have done so well in this war, with horses. The analogy is justified by events, because no thoroughbred has ever been a finer piece of work than are the fighting aeroplanes that saved the British Army in Flanders, and saved England from really serious bombing, such as Poland suffered, and have done much to save this island from invasion by sea by preventing the enemy's Air Force from getting such command of the air along the coast as is necessary before landings can be made from the sea.

Anybody who has ever taken an interest in the pedigrees of horses, dogs, or even coloured mice, must have been fascinated by the way in which family characteristics come down from generation to generation. And those who take an interest in human pedigrees, as well as those who do not, cannot have helped being interested in the romances that have produced progeny some of whom have turned out to be great men and women.

Few human pedigrees can be more romantic than those of the great fighting aeroplanes of this country.

I propose to deal with the pedigrees of our fighters alphabetically, so that nobody can accuse me of favouritism, and so that anybody who likes can, when he gets to the last of them, say, 'Last but not least.'

Chapter 13

THE BRISTOL BLENHEIM FIGHTER AND THE BEAUFIGHTER

In the year 1909, when Louis Blériot flew the Channel, and first impressed upon the people of this country that Britain was no longer an island, two brothers named Harold and Frank Barnwell were experimenting with an aeroplane in Scotland. It never actually flew, but it did hop off the ground —and like most such machines it ended in a heap.

At that time the great Bristol merchant-venturer, Sir George White, Bart., had built for himself the position of the tramway king of Great Britain. He bought up every horse-tramway on which he could lay his hands and electrified it. Also he gave the City of Bristol the best motor-bus and motor-taxi service in the country. Thus he acquired such an interest in transport that as soon as flying began he saw the immensity of its future.

So he caused to be registered the British and Colonial Aeroplane Company, Limited. To that company in 1910 came Frank Barnwell, with good sound Scottish engineering experience and a knowledge of everything that had to do with aviation.

Frank Barnwell became chief designer. In 1913 he produced a tiny biplane with a 50-h.p. rotary Gnôme motor

which had an astonishingly fine performance. It was very fast for those days. Its speed was, I believe, nearly 90 miles an hour. It was beautiful to fly, it made perfect landings, and it was gentle and obedient.

At that time No. 3 Squadron, Royal Flying Corps, was stationed at Larkhill on Salisbury Plain, where the Bristol Company had already built a row of sheds. Even before that the first of the Army fliers had flown at Larkhill. So when the little Bristol Bullet appeared it had a keenly critical and appreciative audience. Everyone liked it, and by 1914 it was accepted as one of the standard Scouts of the Royal Flying Corps.

At the outbreak of war Frank Barnwell, who was a captain in the Special Reserve of the Royal Flying Corps, went to France with his squadon, but he was soon pulled back and told to go and make more aeroplanes. The result was the small high-peed monoplane fighter which I have mentioned in the first part of this book.

More important still was the historic Bristol Fighter two-seat biplane, with a Rolls-Royce motor, a machine that did as much to win the war as did any mechanical apparatus. And it went on for years after the war as a general purpose machine, loaded like a Christmas tree but always flying.

Frank Barnwell told me, early in his career as a designer, that his idea of an aeroplane was the biggest possible motor with the smallest possible aeroplane behind it. That description did not apply to the Bristol Fighter, which was a big aeroplane, but it did apply to the little monoplane and later on to the Bristol Bulldog—a single-seat biplane which became one of the standard fighters of the R.A.F.

Frank Barnwell always thought far in front of his time. An excellent example was a single-seat monoplane which he built in about 1923. It had a body the shape of an egg, with the engine completely buried in the nose, little monoplane

wings sticking out amidships, and an undercarriage that retracted into its belly. And that was years before anybody seriously thought of retractable undercarriages. There was so much other work to do at the time that he never developed the type, but it was a brilliant conception.

Sir George White unfortunately died during the War of 1914–18, so he never saw his great air schemes fully developed. But he saw enough to justify him in his faith in the future of aviation.

After his death his brother Mr. Samuel White, his son Sir Stanley White, and his nephews, Verdon Smith, Sidney Smith, Henry White-Smith (the last-named was knighted, as chairman of the Society of British Aircraft Constructors), and Lady White's nephew, Herbert Thomas, carried on the good work, and Bristol designers always had plenty of financial backing whenever they wanted it.

Consequently when the world's fashion in aeroplanes changed over from stick-and-string and fabric to all-metal design, the Bristol company showed what they could do. Frank Barnwell, and his assistants Messrs. Frise and Pollard, collaborated in the design of an all-metal twin-motor monoplane. Before the whole machine was built, the fuselage only was shown at the Paris Aero Show of 1935, where it caused a great deal of attention because of its beautiful detail design and workmanship.

Just about that time various notable people were acquiring aeroplanes for their private transport. Lord Beaverbrook, later Minister for Aircraft Production and a Member of the War Cabinet, bought himself an American twin-motor ten-seater aeroplane, so Lord Rothermere, for many years his rival in the newspaper business, looked round for something all-British. One of his advisers pointed out this beautiful Bristol aeroplane in the making. So he ordered one.

Just about then this country began to wake up to the idea

that comparatively speaking we had no air strength—although in fact, the Royal Air Force at that time was as strong as any other and much more efficient—so Lord Rothermere, to encourage British aviation, presented his beautiful new Bristol monoplane, which he had named 'Britain First', to the Royal Air Force.

As ordered by Lord Rothermere, it was naturally to be a luxury air yacht. But the original Bristol design had been for a bomber-fighter. So, when the Air Ministry intimated that they were interested in this type, the designers altered the original machine, which had been a mid-wing monoplane, and turned it into a low-wing monoplane. And by 1936 the Blenheim appeared as a self-defending bomber. It had a couple of guns forward, a couple of guns aft, and for its time and type it was very fast—somewhere around 230 m.p.h.

Quantities of these were built for the Royal Air Force and a lot more were sent to Australia. Some were sold to Rumania, Turkey, and Sweden, because it was a useful dual-purpose machine, which could either fight or bomb. Whether we were wise in supplying war material to other nations is a debatable question. But the fact that they bought it shows what they thought of our products.

Frank Barnwell was killed in a lamentable accident to a little aeroplane which he had built for his own amusement. He had gone back on his basic ideas, for instead of having the biggest possible engine with a small aeroplane behind it, he had a small aeroplane with a small engine in front of it, which got him off the ground just high enough to kill him. Everybody mourned him as a pioneer who had done great service to the country, and those who knew him well lost a very dear friend.

His successors, Messrs. Frise and Pollard, carried on his work, and when war was declared the Blenheim was one of the leading types in the Royal Air Force. It had some curious

tricks, just as a good horse may have curious tricks, but when once the pilot learned them, it was a very safe aeroplane.

It was supposed to be a medium bomber, but it was turned on for all sorts of jobs. In the Norwegian affair, when none of our fighters could go so far from home, certain Coastal Command officers somehow put more guns on the Blenheim, carried fewer bombs, and made the machine a long-range fighter.

There is a good story of two Blenheim fighters which were sent out from a Coastal Command station to meet at a pre-arranged point near the coast of Norway a formation of bombers, which they were to protect while the bombers bombed. They got there, by some mischance, fifteen or twenty minutes early. A wireless signal told them to wait for the bombers. The leader replied, 'Signal not understood', and the two went in and shot up the Norwegian aerodrome by themselves.

The Germans were taken by surprise. The Blenheims flew round the aerodrome machine-gunning everything in sight and disappeared over a hill in the direction of home. As soon as the Germans got to work pulling their wrecked machines out of the way before trying to repair them, the Blenheims came round again from behind the hill, and shot them up a second time. Then they did go away. Fifteen or twenty minutes afterwards, when the Germans decided that they had gone, the bombers came in and made an awful mess of the place, because the Germans thought that the other two attacks were their ration for that night.

Later on, during the rout of the French Armies, the Blenheims with the Advanced Air Striking Force, instead of doing their jobs as medium bombers, were turned on to do what should have been done by proper ground-strafing aeroplanes, if anybody had been intelligent enough to develop the type before the war. Their losses were heavy, but they did

magnificent work. As one of their commanding officers said, 'The Blenheims have had to go and poke their noses right down into it.' And they did.

So well did they turn out as extemporized fighters just with extra guns sticking out of their windows and noses, besides the original guns on top of the fuselage, that they were modified by their own designers and by the R.A.F. armament people in collusion, and a battery of guns was fitted in a kind of trough or coffin underneath the fuselage. This gave them as much fire-power as the Spitfires and Hurricanes. Naturally, as the Blenheim had been intended for bombing, they could carry petrol for much longer range, and ammunition for more firing than could the single-seat fighters.

Although they are not so fast as the single-seaters, they have proved themselves well able to catch anything other than the enemy's fast fighters.

The guns below are fired by what is called remote control, that is to say, something more or less on the principles of the Bowden wire. They have worked excellently against attack by German fighters diving from above or zooming from below.

Although not designed primarily as a fighter, the Blenheim has more than justified its existence, and it has worthily upheld the reputation that Sir George White and Mr. Barnwell built up for Bristol products all over the world.

We have already heard something more of Bristol multi-gun, twin motor fighters: the Beaufort, which is primarily a torpedo-bomber, and the Beaufighter, which really is a fighter. Here I naturally cannot say more than that the Bristol designers have kept their ideas well up to date and have developed these types from the original all-metal Bristol fuselage of the Paris Aero Show.

Chapter 14

THE FAIREY FULMAR

Before anybody had flown in this country, a young electrical engineer named Charles Richard Fairey began to take a vivid interest in aerodynamics. He was at about that time a lecturer on science at the Finchley Polytechnic, and the problems of inherent stability particularly puzzled him. Inherent stability is the quality that prevents an aeroplane from capsizing in the air, nose-diving unintentionally, stalling catastrophically, spinning out of control, and otherwise behaving in ways that cause death and destruction.

In pursuit of these problems he made many model gliders and elastic-driven experimental flying machines. In those days—1909—model-flying competitions were popular among the young who could not afford to pay for flying in real aeroplanes, or associate with the rich young men who patronized aerodromes. And because Fairey's flying models were well and scientifically designed, and had the additional advantage of being launched from his unusual height—he was about 6 ft. 6 in. in his socks—they won many competitions.

At that time I was editing one of our earliest flying papers, *The Aero*, for Iliffe & Sons, Ltd., of Coventry, now owners of *Flight*, and naturally we had a lot to say about young Mr. Fairey and his theories of inherent stability. At the same time Mr. J. W. Dunne, of the Middlesex Regiment, since famous among highbrows as the author of that strange book, *An Ex-*

periment with Time, was experimenting with an inherently stable biplane at Leysdown in the Isle of Sheppey. And he came in touch with young Fairey over their mutual interest in stability.

In 1909 the Aero Club of Great Britain, not yet Royal, transferred its flying ground to Eastchurch, some miles farther west on the island, where Mr. Frank McClean (now Sir Francis) had bought a large tract of open ground. He let it to the Aero Club at a rent of one shilling a year. By 1912 it had become the training-ground of the Naval Wing of the Royal Flying Corps, and in 1914–17 it was the flying Headquarters of the Royal Naval Air Service.

Thither from Leysdown came Short Brothers, formerly official balloon-makers to the Aero Club. By 1910 they were the representatives of the Wright Brothers in Great Britain, and were building a number of experimental aeroplanes for Mr. Frank McClean, from which evolved the biplanes on which the Navy's first pilots learned to fly. And the Dunne biplane came along too.

The result of their common interests was that Fairey joined Dunne as his chief engineer, and worked with him for several years. Naturally, in that time he came to know the Short Brothers and all the naval officers who, by 1913, were the majority of the fliers at Eastchurch. So, when orders for Short biplanes for the Navy made the Shorts increase their establishment, Fairey was appointed works manager.

In that job he built those early sea-going tractor biplanes on floats that were, in fact, the foundation on which our air power over the sea was founded, and, although the Fairey company has built many fine landplanes, they have always kept in close touch with the Navy's needs.

Early in 1915 C. R. Fairey became connected with a group of financiers who started him in business on his own account as the Fairey Aviation Company Ltd.; but after a little while

he emerged as the sole owner of the business. The story of those financiers would make a real romance of commerce if one could tell it. Perhaps Mr. Fairey will write an autobiography some day.

Since C. R. Fairey got full control the Fairey Company, under its various titles, as it has grown and been financed afresh, has never looked back. One of the early partners, who joined the young firm during the war, when it wanted ready cash, told me years afterwards that he had never had less than the original amount of his investment as an annual dividend. Naturally no firm pays 100 per cent on ordinary share capital, but the Fairey Company has been steadily and deservedly successful.

During the thin time after the War of 1914–18 Mr. Fairey adopted an enterprising policy. As soon as the Air Ministry issued a specification for a new type of aeroplane, he at once built a machine to beat it, and had it flying within a few months. Consequently while other firms were arguing with Air Ministry technicians about theoretical details, and building prototypes under Air Ministry supervision, Fairey used to go to the Air Staff and say, in effect, 'Here is something to beat your specification. You won't get any of the others for a year or so. Why not have a few of these as a stop-gap?' So at one time there were more of these Fairey 'stop-gaps' of one type or another in the R.A.F. than there were of all other types put together.

Here again the Schneider Trophy Contest comes into the history of our fighters. The Fairey Company built a big biplane on floats for the first Schneider Contest after the war, flown along the coast off Bournemouth. It was piloted by Lieutenant-Colonel Vincent Nicholl, D.S.O., D.S.C. (R.A.F. retired), and put up a fine show, but Colonel Nicholl missed a turning-point in the sea-fog that blew up. So did everybody else, and nobody won.

Four years later, as told elsewhere, the Curtiss Company sent over a team which won the Schneider Trophy at Cowes, and profoundly influenced Mr. Fairey's designs and policy. From those Curtisses came the Fairey Fox. And from it later came the Fairey Battle, which has been built in enormous quantities for the past four years—but is now obsolete.

In 1934 the Air Ministry issued a specification for a two-seat monoplane which might be either a fighter or a reconnaissance machine. The Fairey Company, as usual, set out to beat the specification, and produced the P4/34. That is their fourth lay-out of a design as a private venture to beat that specification.

The P4/34 was a splendid aeroplane. It did all that the Battle did, and was faster. But the Battle was already in production in big quantities, and no change could be made. Then, early in 1939, the Admiralty induced the Government to make over the Fleet Air Arm to the Navy, instead of leaving it a branch of the R.A.F. And the Navy set up its own Material Branch, which meant that although its aeroplanes had to pass Air Ministry (later Ministry of Aircraft Production—M.A.P.) inspections of material and workmanship, the Navy could insist on having what it wanted.

By this time the Fairey Company had developed the unwanted P4/34 into a first-class two-seat deck-flying monoplane. It was called the Fulmar. And that is how the Navy's newest fighter happened.

Chapter 15

THE GLOSTER GLADIATOR

In the very early days of flying, somewhere about 1910, a young engineer named H. P. Folland joined the staff of that much-abused establishment, the Royal Aircraft Factory at South Farnborough. The Factory, as it was then called, has now become the Royal Aircraft Establishment. The name was changed to avoid the clashing of the initials with those of the Royal Air Force, which came into being in 1918.

Before the outbreak of war in 1939 the R.A.E. had for a number of years been drawing £400,000 a year from the meagre R.A.F. vote for material in the Air Estimates. What it did with the money nobody knows. When challenged it could never produce in self-defence anything novel or useful, all the way from an aeroplane and/or an aero-engine down to small instruments or fittings. Nevertheless, some very good men had come out of the Factory. Doubtless they came out because they were good men, and could see no future if they stopped where they were.

One of the best known of them was Captain Geoffrey de Havilland, the originator of the famous D.H. series of aeroplanes. Another of them was H. P. Folland.

While he was at the Factory, young Mr. Folland designed an aeroplane which was called the S.E.5a. S.E. stood for 'Scout Experimental'. Readers will remember that early in this book I said that the early high-speed fighters were al-

ways called Scouts. The 5 indicated that it was the fifth attempt of the Royal Aircraft Factory to build a fast single-seater, and the 'a' indicated that it was the first modification of the S.E.5.

It was for its time a first-class aeroplane. Its top speed with a Vee-8 water-cooled motor, which gave a rather doubtful 180 h.p., was somewhere about 135 m.p.h., which was very good indeed. Besides being fast the S.E.5a was beautiful to handle. Pilots used to throw it about in absurd attitudes, but it always stood up to ill-treatment.

During the war of 1914–18 H. P. Folland was induced to leave the Factory and to join the Nieuport and General Aerocraft Company Ltd., which had been started by Sir Samuel Waring, afterwards Lord Waring (since deceased), of Waring & Gillows in Oxford Street, who had been ambitious before the war to become an aircraft manufacturer. The idea was to exploit the famous French Nieuport design in this country. But there was, in fact, nothing extraordinary in the Nieuport design, so Folland proceeded to build modifications of it that were much better than the original Nieuport.

I remember particularly one machine he built just before the end of the war, called the Nieuport Night-Hawk, which was intended to be a night-flying fighter. Its job was to find and kill enemy bombers that came over to this country and made a nuisance of themselves by shutting down nightshift work at factories and causing loss of man-hours—just as night raiders do to-day.

The Night-Hawk was good and was doing excellent execution when the Armistice came. But after the Armistice there was no more demand for aeroplanes and Sir Samuel Waring, who was generally considered to have been given his knighthood for his services to aviation, closed down the British Nieuport Company.

Early in the War of 1914–18 the old-established and much-

respected firm of H. H. Martyn, in Cheltenham, whose special line was fitting up the interiors of luxury liners, and incidentally the making of statues and memorials, all exquisite work, had been induced to come into the aircraft industry and make aeroplanes. The Gloucestershire Aircraft Company Ltd. was registered in 1915 as an offshoot of it.

Soon after the war, when Sir Samuel Waring shut down the British Nieuport Company, H. P. Folland, with his two chief assistants, H. E. Preston and S. J. Waters, joined the Gloucestershire Company.

In 1921 Folland and his associates produced the record-breaking Mars I, commonly known as the 'Bamel', a racing biplane with a Napier Lion engine, which won the Aerial Derby in 1921, 1922, and 1923. This machine raised the British Speed Record in 1922 to 212·2 m.p.h.—a speed that would not be despised even to-day.

Later, in 1925, Folland designed a racing biplane with floats, also with a Napier Lion motor, which finished second in the Schneider Trophy Contest of that year.

In these efforts Folland was lucky in having the support of Mr. David Longden, Managing Director of the firm, who realized the importance of record-breaking and competition-flying in building up the reputation of aircraft, or any other species of locomotive or automobile. This first Gloster Schneider machine was a development of the Gloster I landplane.

In 1927 Folland produced another Gloster racing seaplane, also with a Napier Lion. It was flown in the Schneider Contest at Venice in that year and did well. During these years—in which the firm's name was changed from Gloucestershire to Gloster, in the interests of foreign trade—he produced the Gloster Grebe, a biplane single-seat fighter, and the Gloster Gamecock, also a single-seat fighter biplane, both of which became standard equipment for fighter squadrons

in the R.A.F. So, you see, Mr. Folland was excellently qualified by experience and scientific knowledge to build the world's finest and fastest biplane fighter.

For the 1929 Schneider Contest Folland produced the Gloster VI racing monoplane, which seemed to offer less head resistance to the air than anything that had ever before appeared on floats.

During this period the Gloster Company produced a wonderful variety of aeroplanes, all the way from big transport and survey machines down to reconnaissance sea-planes on floats, and various types of experimental single-seat fighters.

By 1931 Folland had taken another step forward. He had produced the Gloster S.S.19, a single-seat fighter with a Bristol Jupiter motor of about 480 h.p. Its special features were that it was built entirely of metal, except for the fabric covering, it had a very well cowled-in motor, and it carried six machine-guns, a thing that no single-seat fighter had done until that date.

Two Vickers guns were fitted in troughs in the fuselage, and the other four were Lewis guns mounted on the wing-struts and firing outside the radius of the airscrew. The rate of fire of machine-guns in those days was much less than it is now; nevertheless, six guns provided a lot of fire-power.

The speed of the machine was about 190 m.p.h., which seems a trifle pathetic compared with our 400 to 450 m.p.h. to-day, but it had an excellent climb, and if it had to attack it got a lot of speed by diving. At any rate, it was a big step forward in fighter design.

Incidentally, after the Schneider Contest over the Solent in 1929, the Gloster VI set up a world's speed record for sea-planes, on September 10 at Calshot, of 336·3 m.p.h.

The metallization, so to speak, of the Gloster machines dated from 1927, when the Gloster Company absorbed the Steel Wing Company Ltd., a firm which had been the pioneer

of the application of steel-strip in aircraft construction. There is interest here in noting that Mr. Mooney, the moving spirit in the Steel Wing Company, had been fighting for steel construction throughout most of the war of 1914–18, and that one of his basic patents, in the name of a Russian called Mayrow, had been initially financed in 1912 or 1913 by Mr. E. V. Sassoon, at Brooklands—now Sir Victor Sassoon, Bart.

The first of the Gloster firm's steel-built aeroplanes to be adopted by the R.A.F. as a standard type was the Gauntlet, which was produced in 1933. This machine carried only two Vickers guns. With a Bristol Mercury motor of about 640 h.p. the speed of the Gauntlet was close upon 230 m.p.h.

Early in 1934 the Gloster Company was taken over by Hawker Aircraft Ltd., of which it has since been a subsidiary. But it has had a completely independent existence under different management and until this war began had retained its own design staff.

Mr. Folland produced the famous Gladiator in 1935. It differs from the Gauntlet in only having one pair of struts outside the fuselage. Everything that can be streamlined about the machine has been streamlined. The undercarriage consists of a pair of cantilever legs, which are supported by their own strength without any bracing. The interplane struts are buried inside the fabric of the wing, and everything that can be done in a braced biplane to reduce head-resistance has been done.

With a Mercury motor of 725 h.p. the speed of the Gladiator went up to 250 m.p.h. And it carries four guns.

It is extremely manœuvrable, and when diving can reach a very high speed without any fear of breaking up. That is why it has been so uniformly successful against both German and Italian bombers.

Early in 1936 H. P. Folland, with his chief assistants,

Messrs. Preston and Radcliffe, left to form Folland Aircraft Ltd. at Hamble, near Southampton. His last work at the Gloster Company was to produce a multi-gun monoplane fighter with an air-cooled radial motor, which, but for the Air Ministry's concentration on fighters with liquid-cooled motors, would no doubt have been put into production.

In studying the development of the Gladiator, there is much interest in noting how, like the Spitfire, it developed largely from the experience gained in building racers for the Schneider Trophy Contest.

The Gladiator definitely has its own job in any war. Although it cannot touch the speed of the monoplane fighters, it can dodge in and out where they could not go. The R.A.F. can use it for small aerodromes in rough country that would not at all suit the more heavily loaded and higher-speed monoplanes. And the history earlier in this book of what the fighters have already done in this war shows how thoroughly the Gladiator has justified its existence, especially in Norway and North Africa.

Chapter 16

THE HAWKER HURRICANE

In the very earliest days of aviation, when what is now Brooklands Aerodrome was just a rather large clear patch in the middle of the motor track, one of the *habitués* of the track was a young sportsman named Thomas Octavius Murdoch Sopwith. He was called Octavius because he had seven sisters older than himself.

The Sopwith family was wealthy, so at that time he already owned a large six-cylinder Napier car, and sundry motorboats, which were kept in order by a very clever engineer named Fred Sigrist. Naturally, this new sport of flying appealed to such a sportsman, and early in 1910 young Mr. Sopwith came to Brooklands and bought an Avis monoplane built by Mr. Howard Wright, and designed by Mr. W. O. Manning, now a well-known member of the Royal Aeronautical Society.

After flying this machine for some time—it was very experimental—'Tommy' Sopwith, as his friends still call him, acquired a Howard Wright biplane and a Blériot tandem-seat monoplane, and, accompanied by his sister May as business manager, and Fred Sigrist as chief engineer, he went to America.

Although the first flying had been done in the United States by the Wright brothers, any sort of flying was still a sensational performance. So Tommy Sopwith won a variety

of contests, which, I believe, paid for taking the whole outfit to America and bringing it back again, including buying a Wright biplane.

When he returned to Brooklands two young Australians named Harry Hawker and H. E. Kauper joined the firm as mechanics, hoping that they might be allowed to fly.

Harry Hawker quickly showed himself to be an unusually fine pilot. I forget whether Kauper ever flew, but at any rate he became a first-class mechanic, and during the War of 1914–18 he invented and made the Kauper interrupter gear for machine-guns, as already mentioned. So Tommy Sopwith's Australians turned out to be a good investment.

One of the peculiarities of the Wright biplane was that although it was the first aeroplane in the world to fly, it soon came up against an inherent dead-end in its aerodynamic design, which prevented it from being developed any further. But it had certain good points. So Fred Sigrist and Harry Hawker, with the kindly interest of Tommy Sopwith—who always has had an amazing knack of knowing what is right and what is wrong with an aeroplane without having to work it out, proceeded to build a curious tractor biplane which had a rectangular wire-braced fuselage, like any other of the time, but had wings built on the principle of those in the Wright machine—which were of a rather good aerodynamic section and were flexible under the pull of the warp-wires. Ailerons were not used.

This machine, flown by Tommy Sopwith himself and by Harry Hawker, did so well by 1912 that the pilots of the Air Department at the Admiralty, which was just then forming its own Royal Naval Air Service, became interested. Lieutenant Spenser Grey, one of the best Navy pilots, came down and tried it and said that it was the best thing that he had flown. The naval engineer officers approved its construction,

and an order for half a dozen or a dozen was given to the recently formed Sopwith Aviation Company Ltd.

An order of such size in those days meant that a firm was definitely established in the aircraft industry. The couple of sheds in which the company dwelt at Brooklands could not cope with the output, so the firm acquired a disused roller-skating-rink close by the station at Kingston-on-Thames.

I remember that workshop very well. Such things as drawings and stress-diagrams and slide-rules did not trouble the people who built aeroplanes in those days. The first drawings for a new and experimental type of machine, which the firm put in hand shortly afterwards, were done in chalk; the side and end elevations were drawn life size on the walls of the skating-rink and the plan view was on the floor. And I have seen many a worse aeroplane turned out as the result of the most elaborate drawings and calculations.

Now here comes an interesting historical story. When the company went seriously into the aircraft trade as a commercial proposition, on the strength of an order for half a dozen or a dozen machines, Tommy Sopwith told his friend Fred Sigrist that as he had been the engineer of the firm's fortunes, he was entitled to share in the firm's prosperity, so he offered him a bonus of so many pounds—naturally, I must not say the amount—on every machine the firm manufactured. And this is where the romance of the business comes in, as will be seen presently.

After their first big biplane, the firm produced a tiny little biplane with a 50-h.p. Gnôme engine which had a phenomenal speed range. Its top speed, if I remember rightly, was 84 m.p.h., and it touched down when landing at somewhere about 35 m.p.h. I know that its top speed was nearly three times its landing speed. That has remained an ideal ratio of speed ever since—though I admit that we ought to be able to do a lot better than that now with slots and flaps.

During 1913 and the early part of 1914 the Sopwith Company went on building improved versions of their big two-seater reconnaissance biplane, and of the little single-seat Scout, which, because of its small size, was naturally called the 'Tabloid'—a fact that I remember clearly because it was resented by the then directors of the great firm of Burroughs & Wellcome Ltd., the chemists, who had registered the word 'Tabloid' as a trade-mark. They never managed to make the indigenes of Brooklands drop the word, but I think they became reconciled to it afterwards when they found that it had phenomenal success and necessarily reflected an advertising value on their products.

Everything was going excellently when war broke out. The Admiralty promptly ordered the Sopwith Company to turn out every aeroplane that they could manage. The naval engineer officers, Lieutenants Featherstone Briggs and Gerald Aldwell in particular, helped the firm all they could.

The Tabloid was put on floats, for use as a single-seat seaplane fighter. Here I may remark that a version of the Tabloid on floats had won the second contest for the Schneider Trophy at Monte Carlo in 1913. There seems to be a definite connection between our high-speed fighters and the Schneider Trophy Contest.

On its floats the Tabloid turned out to be a most useful little aeroplane. It was quite largely used as a small fast Scout on the primitive sea plane carrying ships we kept in the eastern Mediterranean.

The Sopwith Company remained purely an Admiralty firm until 1915, when its designers produced a two-seat biplane which was known as the '1½ Strutter', because it had a curious arrangement of struts in the centre section, just behind the engine, that looked as if it had only one and a half struts a side.

It was the first aeroplane in which a machine-gunner sat

behind the pilot to protect the tail of the machine. The gun was carried on a ring invented by Warrant Officer Scarff, R.N., who later became a commissioned officer and died about three years ago. The Scarff ring became one of the most important armament accessories in the air war. The gunner stood in the middle and the gun rested on rollers on the ring, so the man could walk round inside the ring standing at the butt of the gun, and could direct the gun in any direction at any moment. During the Battle of the Somme, in 1916, the 1½-strut fighter did much to save the R.F.C. and rebuild its moral state after the Fokker Scourge of 1915.

After the '1½ Strutter' came a development of the Tabloid, called the Pup. It was a wonderfully light, manœuvrable little single-seater, with a rotary engine of about 120 h.p. of any of several makes.

After it, came a bigger version called the Camel, because of the curious hump on the back in which the pilot sat. The Camel had funny tricks; for example, one had to do a right-hand turn with full left rudder. But when one got used to it, there was no finer fighting machine, it was just as marvellous in its way as the Hurricane is to-day.

At the very end of the war the firm produced the Snipe, a still bigger single-seat fighter with a 250-h.p. Bentley rotary motor, designed by the subsequent designer of the Bentley cars. The Snipe was actually the fastest and most powerful machine in the air at the end of the war—another score for the Sopwith Company.

And all this time, without argument, the Sopwith Company, which was a family affair, paid Fred Sigrist his fixed royalty per aeroplane. By the end of the war the firm and its subsidiaries and its subcontractors had turned out many thousands of aeroplanes. Thus Fred Sigrist deservedly became a rich man. I emphasize this point because of what happened later.

When the war stopped, the Government, as is the way of governments, forgot the people who had saved the country and went flat out for a policy of Peace and Retrenchment. The only clever thing they did was to invent the Dole, which half starved workmen and soldiers alike, and so prevented any serious rioting. A suddenly starved man can become dangerous, but a half-fed man never is, because his vitality becomes too low. Anyhow, the Sopwith Aviation Company Ltd. wisely shut down and went into liquidation—there was no dole for them.

Harry Hawker, the test pilot, who was on a fixed rate of so many pounds per machine tested, and had also made a good deal of money, joined in a scheme with Messrs. Sopwith and Sigrist to make a very hot and very pretty motor-bicycle. For this purpose they formed the H. G. Hawker Engineering Company Ltd.

In 1920, after the usual short false boom that follows all wars, came the inevitable slump. And the Hawker motor-bicycle business nearly passed out.

Then one day, when the slump was about at its worst, Fred Sigrist suddenly suggested that the Hawker Engineering Company should start to make aeroplanes again. I say again, because although the H. G. Hawker Engineering Company Ltd. had never made aeroplanes, all the people in it still had that hankering after the air that is incurable.

The partners knew that somebody would have to use aeroplanes. Nations would have to have air forces. Civil aviation would have to develop. Air transport must grow. And the people who made the best aeroplanes would be able to sell them. And the Hawker firm would make the best. A sound line of argument, which paid, as we now know.

Fred said he would put up a handsome sum if the others would come in on it. Tommy Sopwith and Harry Hawker and a sporting friend named Bill Eyre, one of the early

habitués of Brooklands, all put down some money and they started to make aeroplanes. All the old skill of the early Sopwith crowd, and that flair of Tommy Sopwith's own, and the sound engineering training of Fred Sigrist went into the new machines.

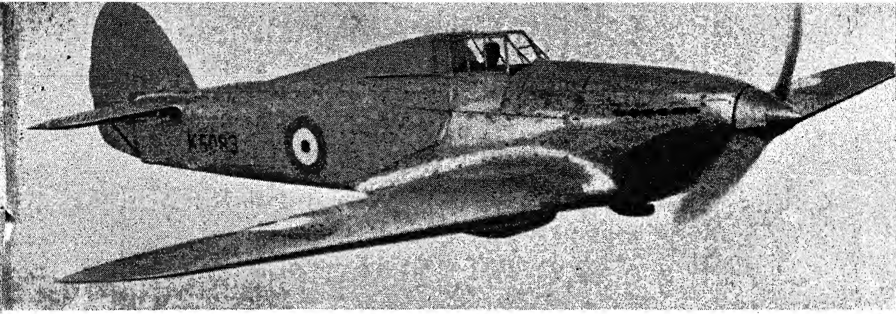
Also the firm acquired as designer a certain Sydney Camm. To-day he is world-famous as the designer of the Hurricane. Sydney Camm—I think I can claim him as an old friend—always reminds me of that favourite American headline—'Local Boy Makes Good'. He started his working life as a wood-worker. As such he went to those two great pioneers at Brooklands, Martin and Handasyde, who during the war made the 'Martinsyde' fighter, as good an aeroplane as anybody had in the war.

George Handasyde soon recognized Camm's ability, and told him to go and study. So he studied, and when the old Martinsyde firm broke up in the slump after the war, Camm joined the Hawker people.

There is no room here in which to recount all the types of Hawker aircraft that were built between their first effort in 1920–2, and the changing of the name to Hawker Aircraft Ltd. in 1933. Nor is there any need here to recount the complicated financial procedures by which the Hawker group first acquired the Gloster Company and then Sir W. G. Armstrong Whitworth Aircraft Ltd. and Armstrong-Siddeley Motors Ltd., and ultimately formed the Hawker Siddeley Aircraft Company Ltd., a holding company which controls all that great group of aircraft and aero-motor concerns.

At first, the Hawker Company built wooden machines, the Woodcock, the Heron, and others. Somewhere about 1925 or 1926 Fred Sigrist developed that simple and highly effective form of fuselage construction which is characteristic of the Hawker aircraft. In essence, it is the old stick-and-string structure over again, but, instead of wooden sticks, steel

Plate 5. The Hurricane Family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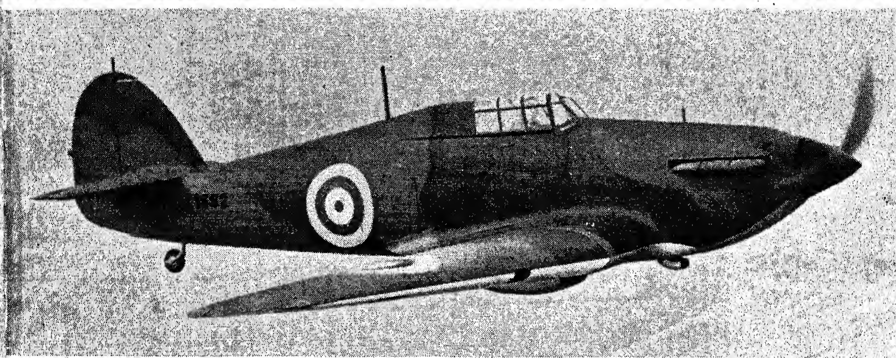
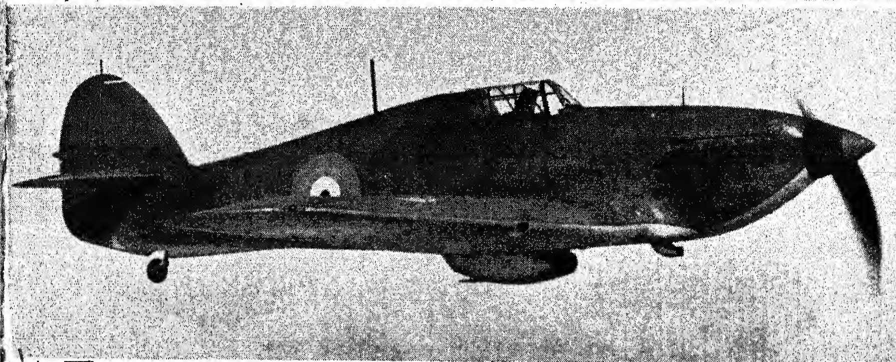
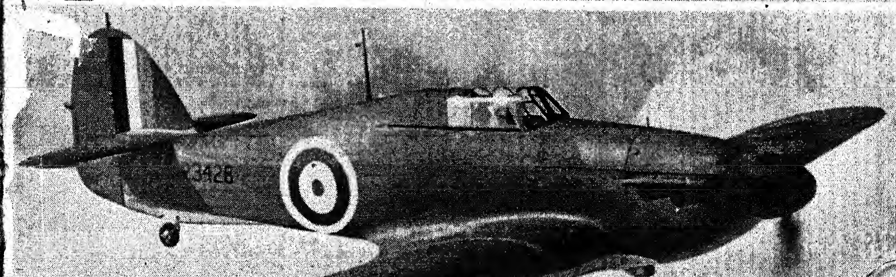
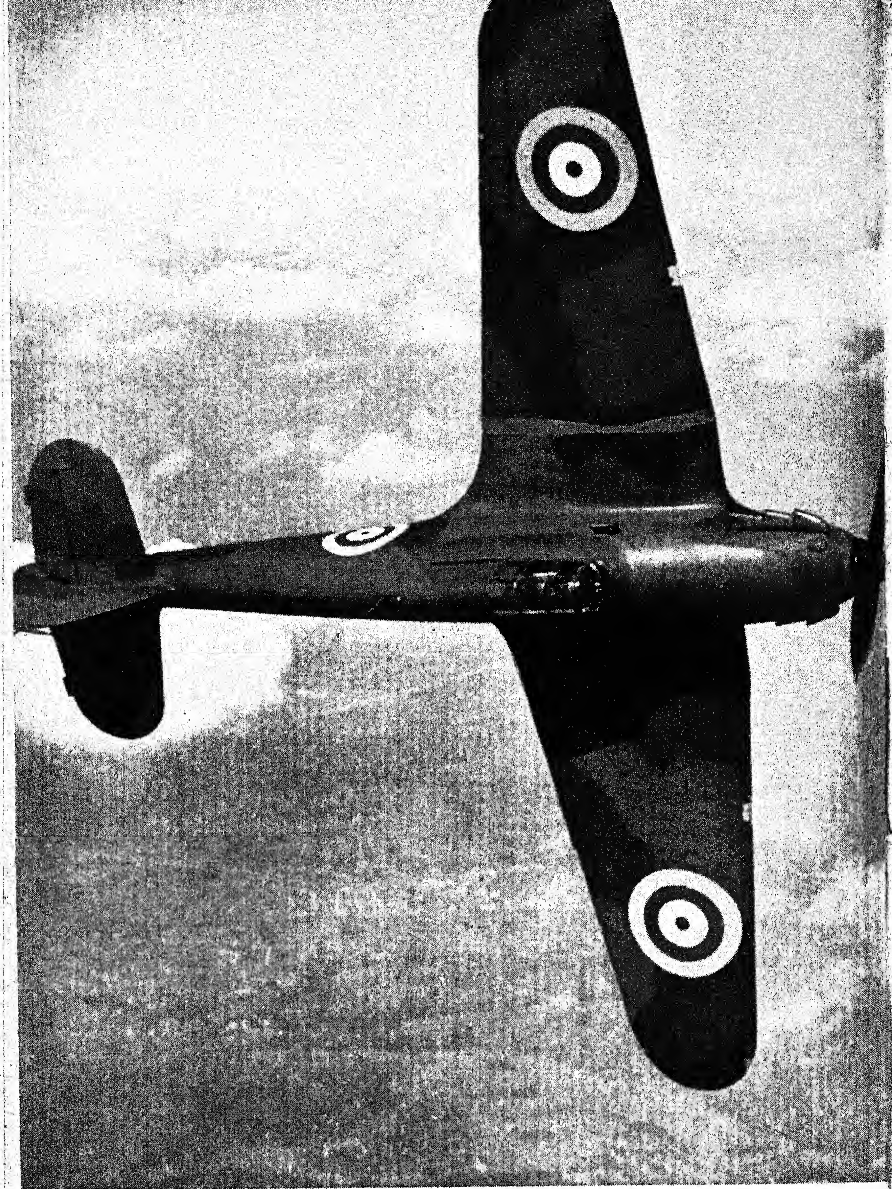






tubing of square section is used for the fuselage, and the whole lot is braced with high-tensile wire. The struts and longitudinals are held in place by ordinary nuts and bolts. It is a beautifully simple system, and there is practically no call for special materials of any sort.

The first of the fighters produced on this system was the Hawker Hornet. That was ordered for the R.A.F. in 1930 and renamed the Fury in accordance with the Air Ministry's system of nomenclature in those days. Its motor was the new Rolls-Royce F engine, which was later renamed the Kestrel. The F was generally understood to be a reference back to the old Rolls-Royce Falcon engine, which had done so well in 1914–18.

One of the first squadrons to be equipped with the new Fury fighter was No. 1, which was very right and proper, because No. 1 had the very last of the Snipe, as related in the first part of this book.

The Fury was a terrific success; and so were all its two-seater derivatives of the Hart class.

There is justification also for the claim that the Hurricane is the descendant of the Hawker Hornbill, one of the first machines to embody fairly high wing-loading with reasonable armament and good flying qualities. It had a Rolls-Royce Condor motor, a high rate of climb, and it carried four guns.

Much of the success of the Hawker series is due to Flight-Lieutenant P. W. S. Bulman, who is generally acknowledged to be unexcelled as a test pilot and exhibition pilot. He was deservedly made, a couple of years ago, a director of the firm which he has done so much to build. For some reason unknown, Flight-Lieutenant Bulman is always called 'George' by friends and enemies alike—that is, if he has any enemies.

He and Sydney Camm are the necessary complement of

Plate 6. Hurricane

one another. If George says there is something queer about the handling or the controls of a machine, then Camm is ready to discuss altering it. On the other hand, George has implicit faith in the engineering ability of Sydney Camm and his staff. I have never heard of a Hawker machine breaking in the air. And they all have a fine performance.

While the Fury was still being developed Sydney Camm and his staff were working on designs for a new monoplane fighter, just as, ever since the Hurricane has been in process of development, they have been working on designs for still bigger and better and faster aeroplanes.

In its early days, while it was still on the drawing-board, the Hurricane was known in the Hawker Company as the Fury Monoplane. At that time the machine was designed for the 660-h.p. Rolls-Royce Goshawk steam-cooled motor, the development of which was dropped when the demand for Merlins became so great.

There is interest here in noting that the Hurricane was not built to an Air Ministry specification. It was what is known in the trade and in the Air Ministry as a 'private venture', or P.V. type.

By 1934 the Rolls-Royce Company had produced a P.V. 12 engine, which gave 1,025 h.p. at 15,000 feet. This motor later became the Merlin 'C', and then the Merlin II, which was the engine used in the Hurricane Mark I.

The Air Ministry did the handsome thing about the middle of 1934, when it produced a specification to fit the general lay-out of the new Hawker monoplane, retractable under-carriage and all.

As a general rule, the Air Ministry experts prepare a specification and the unfortunate manufacturers try to produce a decent aeroplane in accord with it. But this time, it was the other way round. A more than decent aeroplane existed, so the Air Ministry decently wrote a specification round it.

This was known officially as F.36/34, meaning that the Hurricane was a fighter design numbered 36, and that the specification was prepared in 1934. But as the machine already existed the Hurricane design was already six years old when war began.

The first Hurricane was flown by George Bulman on the 6th November 1934. It was the first English fighter that had a retractable undercarriage and an enclosed cockpit, or conservatory.

Since then the Hurricane has been altered very little. The only important alteration is that instead of having a fabric covering, the wings are now all-metal with a stressed skin.

There are people who would still prefer fabric. When a metal-covered wing comes in looking like a pepper-pot because of the bullet-holes through it, the pilot, and particularly the flight-sergeant, wishes that it had the old-fashioned fabric wing-covering, so that he could just dope pieces of fabric over the holes. In a metal wing holes mean sending it into the workshop to be replated.

I remember that when the first prototype Hurricane was being built in great secrecy, Sydney Camm paid me the compliment of showing it to me in confidence. I was admiring the complicated design of the wing, when he remarked, 'I don't know whether the machine will get off the ground, but I will swear that it won't break.' Of course, he knew perfectly well that the thing would fly, and fly well, but he was quite right in his determination that it should never break.

The prototype machine was designed to come out with a loaded weight of 5,700 lb. Production machines are always heavier than prototypes, so the first production machine weighed 5,850 lb. Actually, it flew at 6,000 lb. fully loaded.

After that, various modifications were made which brought the all-up weight to 6,600 lb., which is now the standard flying weight of any Hurricane. Yet, for special purposes, which

we must not specify, it can fly quite well at more than 7,000 lb.

These various increases in weight raised the wing-load from 22·8 lb. per square foot to 25·6 lb. per square foot. That, after all, is quite reasonable loading in these days, when people talk glibly of high-speed, highly loaded bombers at anything between 60 lb. and 90 lb. per square foot.

The Hawker people have been well rewarded for keeping their all-up weight low, because that is what makes the difference between the perfect hunter, of which I wrote at the beginning of this book, and the well-trained racehorse, which has its own particular job to do, quite distinct from that of a hunter.

In its original design the Hurricane was to be armed with four machine-guns, all inside the fuselage, and all firing through the airscrew disk by means of interrupter gears. The idea of giving the machine eight guns in a row outside the airscrew disk, where they could fire at their own limit of speed without any reference to the engine, has been thoroughly sound.

The speed of this first machine with the 1,025-h.p. Merlin engine was 325 m.p.h. at 16,500 feet.

The Hurricane was put into production early in 1936, and the first off the production line, numbered L.1547, was flown in October 1937. This shows the delay between approving a prototype and getting the first machine off the production line.

One could, of course, get the first machines off the production line within a few months of the prototype being approved if one were content to build each machine by hand. Where the time goes is in making special tools for special jobs, fitting up jigs for assembly, and for the drilling of the various parts, and so forth and so on.

Most of this delay of nearly three years was spent in that way. How much of it was wasted by Air Ministry technicians

in making up their minds what they wanted, nobody can say But the time has been got back handsomely since then, because, thanks to proper care in checking up on jigs and so forth, Hurricanes can be turned out in these days like shelling peas.

Fitting the eight Browning guns, four in each wing, naturally complicates the design of the wings themselves, so that they were in effect designed round the guns to give the greatest efficiency.

After its early trials, the tail-wheel was made non-retractable, for the sake of simplicity. In this stage of development, with a two-blade, fixed-pitch wooden airscrews, the top speed of the Hurricane was 330 m.p.h. at 17,000 feet.

No. 111 Fighter Squadron R.A.F. at Northolt made various alterations in the Hurricane, which have been adopted. One of the first was to fit under the fuselage a small fin to stop the machine from spinning in certain positions and conditions. Then came a crop of minor things such as fitting the ejector-type exhaust-manifold, which is alleged to have increased the top speed by about 10 m.p.h. and to have given corresponding gain in cruising speed and a faster climb. More recently, the fitting of the De Havilland and Rotol three-blade constant-speed airscrews has improved the take-off and climb and added about 5 m.p.h. to the speed.

The Hurricane I, in the latest style, with metal wings, ejector exhaust, and Rotol constant-speed airscrew, has a top speed of 335 m.p.h. at 17,500 feet.

Those were the latest figures the Air Ministry allowed to be published just before the outbreak of war. But everybody in aviation knows that by various refinements in the aeroplane and improvements in the motor the speed of the modern Hurricane has been pushed up far beyond those figures. And nobody knows that better than do the German aviators.

On paper the Messerschmitt fighters are supposed to be much faster than the Hurricanes, but the Hurricane pilots have a disconcerting way of pouncing on the Messerschmitts with the force of gravity to help their engines, and the result has been very satisfactory from our point of view.

One of the most interesting facts about the production of the Hurricane is that the men who were responsible for producing it in the first place, and for most of its ancestry, are still very much interested in it.

Mr. T. O. M. Sopwith, in spite of his interest in all the Hawker-Siddeley group of companies, which, as I said earlier, includes the Gloster Company, still keeps a loving and fatherly eye on the Hurricane. Fred Sigrist, who retired because of ill health in 1939, was very much on the watch over Hurricane production.

Mr. F. S. Spriggs (now Sir Frank Spriggs), chairman of the Hawker-Siddeley Group, and now chairman of several Government Committees appointed by Lord Beaverbrook, Minister for Aircraft Production, to regulate the supply and boost the production of aircraft material, started his commercial life with the old Sopwith Company. And Mr. H. K. Jones, now Managing Director of the Hawker Company, began his business life as an apprentice with a motor firm in west London, came to the Sopwith Company during the last war, and has risen steadily to his present eminent position. Sir Frank Spriggs and he have been particularly responsible for administration and organization, and they may well be proud of their work.

Another interesting fact is that, as the German Intelligence Department very well knows, the oldest of the Hawker works is within a hop, skip, and a jump of the old skating-rink at Kingston, where the very first of the Sopwith aeronautical progeny were generated.

THE TORNADO

In November 1940 an American aviation paper published what purported to be descriptions of the newest English 'airplanes'. Much of these descriptions was imaginative. Some part of them was deductive. And some part of them was accurate—at any rate enough of it to show that somebody had talked more than he should have done—though one could hardly call it a serious leakage of secret information, for everybody in the R.A.F. and the British aircraft industry had been talking about these aeroplanes for months, or even for years.

Nevertheless, unless the Ministry of Information and the Ministry of Home Security and the Public Relations Directorate of the Air Ministry and the Ministry of Aircraft Production all agree to 'blow the story wide open'—as the elegant American language has it—there is little likelihood of our new fighters being described in detail until they have been used in quantities over Germany, and we are certain that enough of them have fallen into enemy hands to give the German technicians all the information that they want.

The probability is that when this book appears the fighters, at any rate, will still be destroying German aeroplanes over this country, and so a full description of them is not likely to have been released for publication.

But one may be allowed to say that the Hawker Tornado is the direct descendant of the famous Hurricane. It is the offspring of Mr. Sydney Camm's ingenuity, plus the efforts of his well-trained staff.

Necessarily the Tornado flies faster, farther, and higher than does the Hurricane. Also, naturally, it is more heavily armed, but how or with what must not be told until the Air Staff sees fit to tell the British public what we may then be sure that the enemy knows.

This reticence is common sense. However much the keen student of aeroplane design may wish to know what our fighter pilots are using, keeping the enemy guessing about what he will have to fight is vitally important to the safety of the R.A.F. and, ultimately of this nation.

Some American commentators on our aeroplanes write of twelve Browning machine-guns; others of eight ·5 Colts; others again of six Brownings and four Colts; and yet others of a couple of ·787 (or 4/5 in. or 20-mm.) Suizas and a few Brownings. So there is evidently plenty of choice. And we can let the enemy go on guessing.

Chapter 17

THE VICKERS SUPERMARINE SPITFIRE

Like those of all British fighter aeroplanes, the pedigree of the Spitfire goes back to the pioneer days of aviation. Among the very earliest pioneers of flying in this country was a venturesome young man named Noel Pemberton Billing. He had run away to sea before he was sixteen, had been a trooper in the Natal Mounted Police during the Boer War. He started the first motor paper in South Africa; he had dealt in big and little yachts.

When people began to talk about flying in 1909, he started experimenting on some reclaimed flats at Fambridge in Essex. Later on, when flying was making real progress, he thought he would like to make flying-boats, so he rented a workshop down by the Floating Bridge at Southampton. And because his were to be marine craft which progressed above the water, he called the place the Supermarine Works. There he built a number of interesting and forethoughtful aeroplanes of various very different kinds. When war broke out in 1914 he joined the Royal Naval Air Service and left in charge of his works a brilliant young man named Hubert Scott Paine. After a year of war he sold out to go into Parliament, and at the same time resigned from the R.N.A.S.

The Supermarine Works was bought by private capital and Scott Paine acquired a large interest in them. He sold

out in 1923, and with the money built up the British Power Boat Company, at Hythe, whose speed-boats were known all over the world and are used by the British Navy, Army, and Air Force. But before he left he financed out of his own pocket a sporting effort in 1922 to get the Schneider Trophy back from Italy with a fast flying-boat, which was one of the early designs of R. J. Mitchell.

Soon after Mr. Scott Paine left the Supermarine firm Vickers Ltd. became the proprietors of the business. While in charge of Supermarines Mr. Scott Paine had discovered a brilliant young designer named R. J. Mitchell, who joined the firm as a draughtsman in 1917, and was appointed chief engineer and designer in 1920.

Mitchell was one of the finest aircraft designers this country has had. And he was one of the most open-minded. In 1923, when the U.S. Navy and the American Curtiss Company sent a team over here, escorted by the U.S. Cruiser *Pittsburg*—as the current joke said, to see that the Americans got a square deal—and captured the Schneider Trophy at Cowes, I happened, through some of my American friends, to hear of the Curtiss designers' theory that at the high speeds then reached, something more than 200 m.p.h., the pressure of the air against the leading edges of the planes was so great, and the air itself became so compressed, that very sharp leading edges on the planes were worth while, to cut the air. I told Mitchell that theory and he was interested enough to try it out. Photographs of his earlier Schneider Trophy machines show that he was still thinking seriously about that American theory. And the latest Davis wing on the Consolidated Company's boats suggest that somebody has thought of it again.

Unlike so many well-advertised and more or less successful designers, Mitchell was always ready to listen. Whether because he believed that 'out of the mouths of babes and

sucklings' wisdom might be learned, or because he believed that even fools talk sense sometimes, he was always ready to discuss seemingly foolish ideas, and he always seemed interested.

At first practically all his work was done on flying-boats, and no doubt the Supermarine flying-boats of this period were very good sea- and air-craft. But I know that he always had a hankering after building high-speed light machines. At the Schneider Contest at Cowes in 1923 he took a vivid interest in the Curtiss racers and in their D.12 motors. And when he built his first Schneider racer he admitted openly that he had learned a lot from the Americans.

He was fortunate in that the directors of Vickers-Supermarine let him produce a series of Schneider racers. The S.4 (700-h.p. Napier Lion motor) of 1925 was his first. He started building the machine in March 1925, and it made its first flight in August. On the 13th September 1925, piloted by Captain H. C. Biard, it put up a world's seaplane record of 226 m.p.h., a wonderful performance for only 700 h.p., and with floats.

The machine was sent to Baltimore, U.S.A., to compete in the Schneider Trophy Contest of that year, which was won by the Italians. Unhappily in a test flight it crashed because of wing flutter and was wrecked.

This was a remarkable machine because it was about the first fast aeroplane to be built without any external bracing. Also, besides being a cantilever monoplane, it was a mid-wing monoplane. If that machine could have been flown without its enormous floats it would have put up a marvellous speed.

The centre section of the fuselage was built of steel tubing. And to that foundation were fixed the engine and mounting complete, a monocoque aft section, and the one-piece wing. The floats were of duralumin. And, except for the centre-

section, the rest of the machine was built of wood covered with plywood.

The 1927 Schneider Trophy Contest, which was flown along the Lido at Venice, was the first in which the Air Ministry took part officially. They ordered three Supermarine S.5's. These machines were to be flown by R.A.F. pilots.

The S.5 was developed from the S.4, but became a low-wing monoplane with external bracing wires. It was remarkable for being the first machine in which the radiators were built into the wings flush with the surface, so that they added nothing to the drag. Another of Mr. Mitchell's clever ideas was carrying all the petrol in one float to reduce the effect of the torque of the airscrew.

The S.5 differed from the S.4 also in having the fuselage and floats built of metal, with metal covering on the fuselage. The wings and the tail unit were of wood with plywood covering.

One of the S.5's, which had a geared Napier Lion engine of 875 h.p., won the Trophy. It was flown by Flight-Lieutenant Webster. His average speed over the course was 281·5 m.p.h. The other, which had a direct drive Lion, also of 875 h.p., was second at 273·07 m.p.h. It was flown by Flight-Lieutenant Worsley.

This contest was also remarkable because it was the first time the existing World's Speed Records made by landplanes were beaten by seaplanes.

Later in 1927 Flight-Lieutenant d'Arcy Greig put up a British Speed Record of 319·57 m.p.h. in one of the S.5's. This was faster than the World's Speed Record held by Italy, but it did not beat it by a big enough margin to be officially recognized as a new World's Record.

For the Schneider Trophy Contest of 1929 Mitchell built a rather bigger machine, the S.6. In a general way it was like the S.5, but it was built of metal throughout and was modi-

fied to take the 12-cylinder Rolls Royce R engine in place of the broad-arrow Napier Lion.

In this the radiators were again built into the structure of the wings. As in the S.5, the floats carried the petrol. The oil tank was in the fin, and the oil-coolers along the sides of the fuselage.

One of the S.6's, flown by Flying Officer H. R. D. Waghorn, won the Trophy, the contest for which was flown over the Solent. His speed was 328·63 m.p.h. Only Italian aeroplanes competed, and they were beaten badly.

After all the very real dangers of practising and competing in these precarious high-speed float-planes, Dick Waghorn was killed while doing a simple loop in a large, slow single-engine bomber at Farnborough.

On the 12th September 1929 the winning machine, flown by Squadron-Leader Orlebar, put up the World's Speed Record to 357·7 m.p.h. There is interest in noting that this is about 50 m.p.h. slower than the speed of the modern Spitfire at its operating height.

When the time came for thinking about the 1931 Schneider Trophy, we looked very like not being able to compete. And we had only to win the contest once more to make the Trophy our own.

Perhaps I ought to note here that the Schneider Trophy had been presented to the Fédération Internationale Aéronautique by Monsieur Jacques Schneider, son of the great French armament manufacturer, in 1912, for an international seaplane race. The conditions were that any country which won it three times in succession or four times in all was to keep it. If the Italians had won in 1927 they would have kept it. We had to win it in 1931 to keep it ourselves. Incidentally, it had been in the possession of the Royal Aero Club throughout the War of 1914–18, and was familiarly used as a hat-rack.

In 1931, for some reason, the Air Ministry decided that it would not finance another try for the Trophy. The British aircraft trade collectively were not interested in sporting flying; still less were they interested in high-speed float seaplanes.

The Society of British Aircraft Constructors did not feel like clubbing together for an effort that would necessarily bring credit to one aircraft constructor and one aero-motor constructor only. Neither the Royal Aeronautical Society nor the Royal Aero Club was in a position to find the money. So we seemed likely to lose the Trophy to Italy if the Italians sent over anything like a fast machine to fly over the course.

There was much mutual recrimination among the various interests in British aviation. The Air Ministry said that the Trade ought to finance it, and the Trade said that as the Air Ministry had taken the thing out of their hands the year before it should go for it again.

Just when the whole thing looked like falling through, a strong-minded and rather eccentric woman, Lady Houston, who had formerly been Lady Byron, and was now the millionairess widow of Sir Thomas Houston, one of our great shipowners, came forward in a very sporting way and said that she would put up £100,000 to finance the building of machines to win the Contest and to pay the incidental expenses of running the show.

Even then certain personages in the Air Ministry argued whether a Government department could decently accept the widow's mite, more familiarly called Lucy Houston's lot, to finance a contest that was primarily the interest of the aircraft trade. But newspaper pressure, as usual extremely patriotic, rather forced the hands of the Service members of the Air Ministry. And of course the political members were all in favour of taking the money.

There was then no time in which to build a team of new

aeroplanes for the contest, so the two original S.6's were modified to meet new requirements of seaworthiness, and two more were built to a somewhat improved pattern. The original S.6's were called the S.6a and were given new floats and additional cooling circuits on the floats, so that they could keep the great Rolls-Royce motors cool at full throttle.

The S.6b's, the two new machines, were given Rolls-Royce R motors which had been boosted up to give 2,300 h.p., against the 1,900 of the earlier type. For these big motors extra cooling surface had to be fitted. This now covered the whole lower and upper surfaces of the wings and the top surfaces of the floats. The radiator surface thus carried was equivalent to practically the whole external surface of the aeroplane itself.

To the technically minded I may say that something like 40,000 British Thermal Units of heat had to be dissipated per minute from the water and oil cooling surfaces. Scientifically this was reckoned to be equal to about 1,000 h.p. given away in loss of heat.

The S.6b's were designed and built in little more than six months, which is conclusive evidence of R. J. Mitchell's ability both as a designer and a worker.

The Italians, having seen something of the performance of the new machines, decided not to compete, so one of the S.6b's was flown over the course by Flight-Lieutenant J. N. Boothman, at 340·8 m.p.h.—quite a tidy speed, but the machine was not forced all out, as the great object was to cover the course and make sure of the Trophy.

But on the 29th September 1931, Flight-Lieutenant George Stainforth went for the World's Speed Record in one of the S.6b's and put it up to 407·5 m.p.h. This was the first time any living being had travelled at more than 400 m.p.h.

For this effort the Rolls-Royce motor was specially boosted to give 2,600 h.p. over a short distance.

Here there is interest in noting that this aeroplane had a span of 30 feet; a weight empty of 460 lb.; a fully-loaded weight of 5,995 lb.; a wing-loading of 41·3 lb. per square foot; a power-loading of 2·6 lb. per h.p.

That was the end of Mitchell's float seaplane designing. The use to which he put the lessons he had learned was to make the world's fastest single-seat fighter.

What became of the S.6's I do not know. Some months after the Contest I went into the big Supermarine hangar at Hythe, and there they all were, sitting on their floats, without any engines. And somebody said, 'For goodness sake don't say anything in print about these machines, because nobody knows whether they belong legally to Lucy Houston, or the Air Ministry, or Supermarines.'

About that time the Air Ministry issued a specification for a single-seat fighter, to which Mitchell produced the machine called the S.7/30. The designer was necessarily hampered by official restrictions.

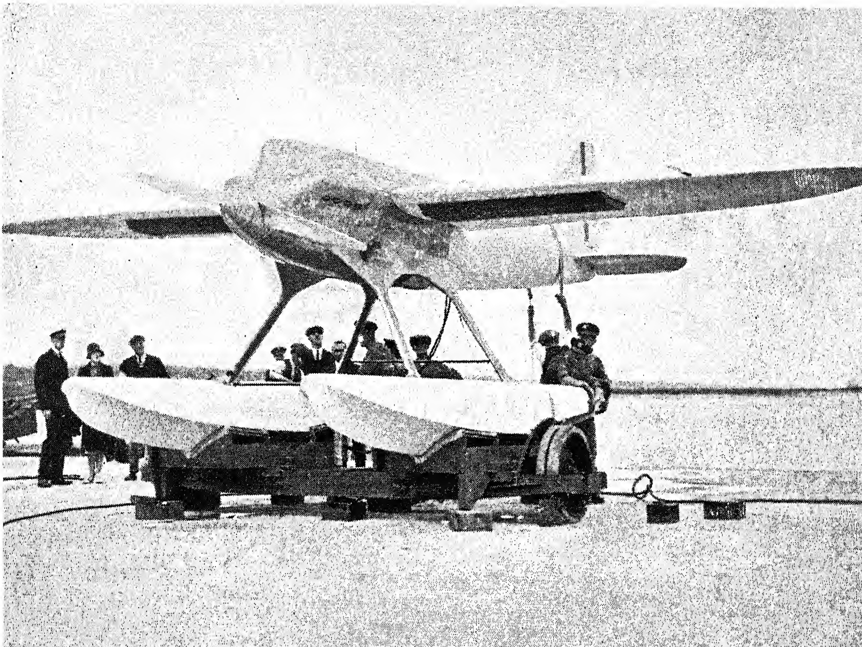
The S.7/30 was not an outstanding success. Its top speed was only 230 m.p.h. It had a steam-cooled Rolls-Royce Goshawk motor of some 660 h.p., which gave a certain amount of trouble, and the aeroplane was really too big for the power.

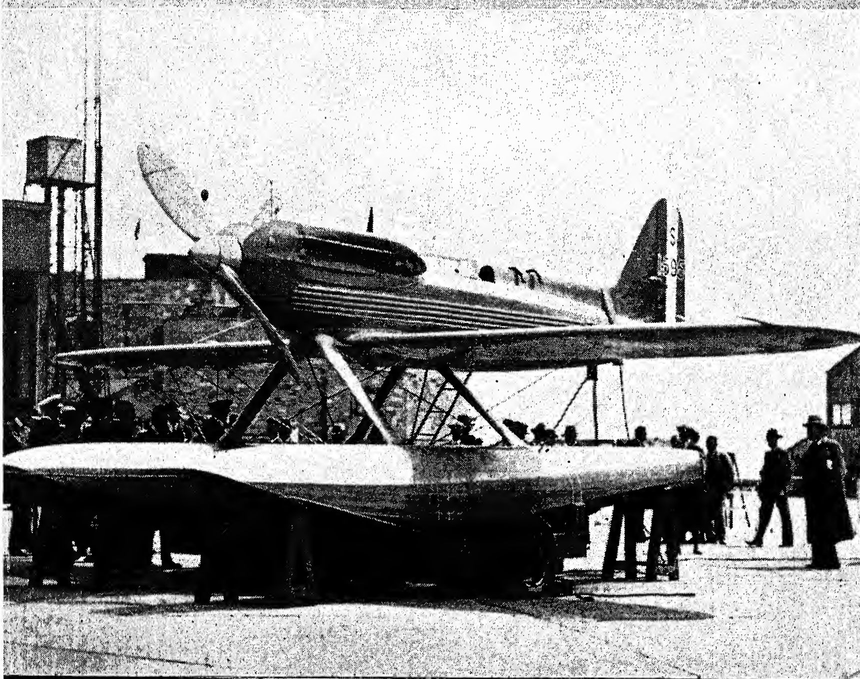
While in its embryo stage this machine was officially called the Spitfire. But the name was dropped.

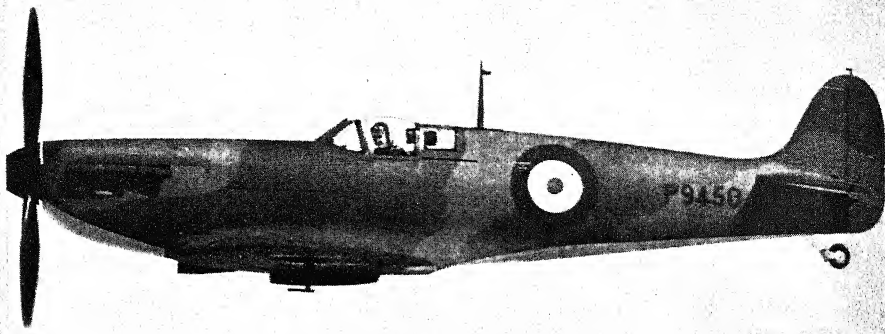
After that Mitchell, encouraged by his directors, decided to design a high-speed fighter free from restrictions. The result was the Spitfire I, which flew for the first time in 1936. It had a fixed-pitch airscrew and stub exhausts, and it had a top speed of 346 m.p.h. at 17,500 feet.

The World's Landplane Speed Record at that time stood at 362 m.p.h., but it was raised to 379 m.p.h. by a specially modified German Messerschmitt 109 fighter before the Spitfire had a chance of trying to beat the record.

Plate 7. Schneider Trophy Supermarine, 1925 and 1930



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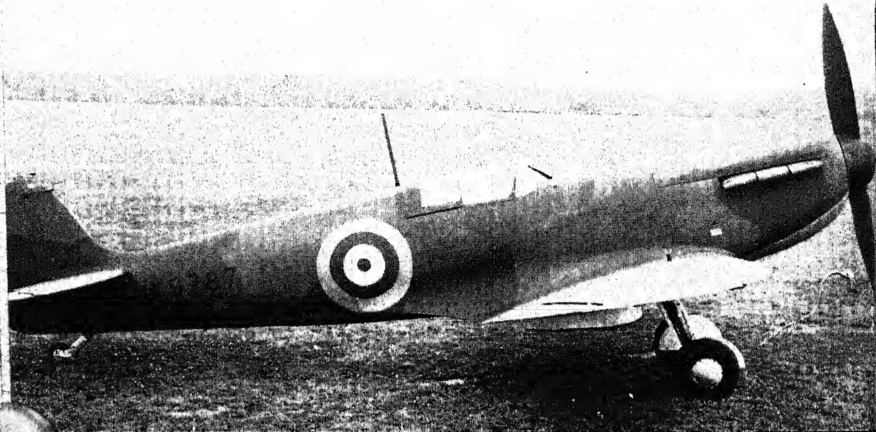


This prototype Spitfire appeared in the New Machine Park at the R.A.F. Display at Hendon in 1936 and it flew at the S.B.A.C. Display that same week-end. It did not appear at the Hendon Display of 1937—the last display given by the R.A.F. The official explanation was that it was no longer a new type. And yet there were no squadrons of it among the performing aeroplanes.

The first fighter squadron to be equipped with Spitfires got them in July 1938. There is no harm now in saying that the delay of two years was caused by a series of unfortunate mistakes among sub-contracting firms who were making bits and pieces.

The Supermarine people had arranged to have parts 'made out'. This was in accord with the modern practice, here and in Germany, of 'dispersal', so that if one factory is bombed the parts will continue to come in from outside factories in other places. Various sub-contractors went ahead gaily making the different parts—rudders in one place, elevators in another, fins in another, under-carriage parts in another, and so on. And when the central assembly plant came to assemble them, they found that the bits and pieces did not all fit, or 'marry up', as the workshop phrase has it.

One of the foreign air attachés in 1939 referred brightly to this unfortunate incident as 'the jigsaw puzzle which did not fit'. Nobody in particular was to blame, or was blamed, for the mishap. But it delayed the official output considerably.

Anyhow, when the production Spitfires did come out, their performance had been put up to 362 m.p.h. at 18,500 feet, by various refinements in detail. The first version had a two-blade fixed-pitch wooden airscrew. A little later three-blade controllable-pitch screws were fitted, which with other improvements raised the speed to 367 m.p.h.

Still later, constant-speed airscrews were fitted, and the highest grade petrol, which is known technically as 100-oc-

Plate 8. Spitfires

tane, was used, which allowed the use of higher compression in the motors. With it the Rolls Royce Merlin gave something like 1,250 h.p. at rated height.

With all these improvements, technicians calculate the speed of the Spitfire a year or so ago was about 387 m.p.h. at 18,500 feet. Other improvements have been made both in the motor and in the aeroplane since then, so one may safely assume that the speed is something well over 400 m.p.h.

The tragedy of the Spitfire is that its brilliant designer, R. J. Mitchell, did not live to see its ultimate success. He died of cancer in 1937, when only forty-two years of age.

Few men have been more deeply mourned by those with whom and among whom they worked. He was always ready to stand up to his seniors if he thought that their views or their decisions were wrong. And he was equally willing to listen to suggestions of his juniors. I know of nobody who worked under Mitchell who did not love and respect him.

Before he died he had the satisfaction of knowing that he had produced a great aeroplane, and he could see how the performance was going to be improved.

I do not know what sort of monument has been raised to his memory, but he has the greatest monument that any man can have: he lives in the memories of those among whom and for whom he worked; that is to say, the officers and men of the Royal Air Force. He played a great part in giving them that complete supremacy over their enemies which enabled the British Navy to save 337,000 British soldiers from the quays and beaches of Dunkirk, and to defeat utterly the German attempt in September 1940 to invade this country.

To-day the Spitfire III, with a still more powerful Rolls-Royce engine, is reckoned to be as fast as any destroyer of the skies, and well able to tackle the latest German products, whether with one motor or two.

Chapter 18

THE BOULTON-PAUL DEFIANT

Like all the rest of the fighters that have done so well in this war, the Boulton-Paul Defiant, although a very young aeroplane, has quite a respectable ancestry. In 1912 a young man named J. D. North, who was a pupil in the drawing-office of the Grahame-White concern at Hendon, won a competition for general knowledge of aviation promoted by a small, one-year old paper called *The Aeroplane*. If I remember rightly, the prize was five pounds, and the judge was Mr. W. O. Manning, himself one of the pioneers of aviation.

During the earlier part of the War of 1914–18 young Mr. North worked with the Grahame-White Company as a draughtsman. Later he transferred himself to that old-established firm at Norwich, Boulton & Paul Ltd., whose name was then world-famous as makers of portable bungalows. They were also the biggest manufacturers in the world of wire-netting, of the kind that is usually called rabbit wire. The young members of the firm, the families of Paul and Ffiske, had become interested in flying before the war, and their great workshops and trained workpeople were easily turned over to making warplanes.

North soon developed there into a notable aircraft engineer. And after the war he persuaded the firm to remain in the aircraft business instead of pouching their profits and

getting out, as did so many firms who did well while the war was on.

While with Boulton & Paul Ltd. North produced a number of interesting aeroplanes, mostly twin-motor machines of the fighter-bomber class. If that category of warplane had been developed we might have been in a better position than we are to-day for long-range fighters.

In 1934 Boulton-Paul Aircraft Ltd. was registered as a limited company separate from the parent company, Boulton & Paul Ltd. It was formed to take over that department, together with a one-third share of a concern called Aircraft Technical Services Ltd., which was incorporated in 1931 to hold a large number of patents relating to metal construction.

This concern pooled its interests in those patents of Boulton & Paul Ltd., the Gloster Aircraft Company Ltd., Sir W. G. Armstrong-Whitworth Aircraft Ltd., and the Steel Wing Company Ltd. Thus the Gloster and Armstrong-Whitworth interests of the Armstrong-Siddeley organization, and thus the Hawker-Siddeley interest, were linked in a curious but rather remote way with the Boulton-Paul interest.

At first Boulton-Paul Aircraft Ltd. remained at Norwich and had their works at the famous aerodrome at Mousehold. But in 1936 the firm moved to a brand new, thoroughly up-to-date works at Wolverhampton. There the Defiant was designed, experimented, and, in 1938, put into quantity production.

During those years nobody was allowed to describe it or even to mention the name of it in print, but everybody in the aircraft trade talked freely about it. And there is no doubt that those foreign air attachés who ultimately became enemies knew of it also. Anybody could stand on the road in the neighbourhood of the Wolverhampton aerodrome in 1938 and see it flying.

During this period also Boulton-Paul Aircraft Ltd. produced designs, experimented, and made, a four-gun revolving turret, similar in outward appearance to the famous Frazer-Nash gun turrets, which have saved our bombers during the first year of war. But the Boulton-Paul turret is electrically driven, whereas, the Frazer-Nash is hydraulic.

Those who have been in aviation from its early days will be interested to know that during these developments J. D. North's personal assistant was Captain W. H. Sayers, who was from the very early days of *The Aeroplane* the technical member of my staff and was the technical editor for several years after the last war. Many former officers and men of the Royal Naval Air Service will remember him as the technical officer at the Isle of Grain experimental station.

In 1939 the Defiant had become such an open secret that even the Conservators of Official Secrets could no longer keep it dark without making themselves ridiculous. And photographs of it were let loose for publication.

The Defiant introduced a new line of tactics into air warfare. Until its appearance the pilot of a two-seat fighter was always the captain of the ship and went where he liked. The forward-firing guns were fixed and he aimed them by aiming the whole aeroplane. The back gunner was primarily there to protect the tail of the machine, and perhaps to have an occasional chance of bringing down an enemy aircraft which attacked. But the aft gunner was in no sense an attacker.

For one thing, the armament technicians had for years held that there was no good in trying to fire a broadside out of fast aeroplanes. This belief was held in spite of the fact that during the War of 1914–18 quite a number of aft gunners, in their little Scarff rings, had made a habit of shooting down enemy aeroplanes whose pilots were obliged by their own speeds, when attacking the tail of a plane, to go past it to avoid a collision.

The theoretical technician argued that aeroplanes of those days were so slow that firing broadside did not matter, but that if one tried to fire a bullet broadside across the wind out of an aeroplane diving at perhaps 400 m.p.h., scientific aiming was impossible—naturally they did not allow for the unscientific aiming of men who were merely excellent natural shots, who used their machine-guns as a game shot uses a shot-gun, by instinct or experience.

The theorist proved mathematically and experiments showed that if one fires out of an aeroplane on one side the bullets spin upwards, and if one fires out of the other side, they spin downwards.

This seems natural enough. Twenty miles an hour is thirty feet a second, so 100 miles an hour is six hundred feet a second, or two hundred yards a second. And, no matter how high the muzzle velocity of a bullet, one cannot expect any self-respecting bullet launched into the air while travelling sideways at 200 yards a second to maintain a straight course. And as the speed of the aeroplane when the gun is fired may vary anywhere between 200 and 400 m.p.h., the impossibility of making gun-sights to suit is evident.

The effects of spinning up or spinning down are known as the Cazeau, or Magnus, effects, because they were enunciated, rather than discovered, at the armament experimental establishment of the late lamented French Air Force, *L'Armée de l'Air*, at a little place called Cazeau in the south of France. Other effects had been theoretically calculated by a German scientist, Dr. Magnus.

Regardless of the Cazeau theory, certain armament people in the R.A.F. held that four guns firing tracer bullets at modern high-speed rates, in the neighbourhood of a thousand rounds per minute, would indicate the progress of their fire, and the gunner would be able to aim his ammunition, as one aims a hose, by seeing where the bullets went.

This section of the Staff of the R.A.F. was allowed to have its way, so the Defiant was built. Experimental firing against towed targets showed that the gunner could make quite good shooting sideways anywhere between almost dead ahead and dead astern.

The Defiant first went into action when our fighters were flung into Flanders to save what they could of the British Expeditionary Force—and saved something more than 75 per cent of it, when the High Command had become resigned to losing most of it.

The new principle involved in the tactics of the Defiant was that the pilot had to place his machine so as to give the gunner a chance. The machine carried no front guns, so the pilot had no temptation to go on a shooting expedition of his own. He either had to co-operate intelligently with the gunner, or go where the gunner told him. And the new tactics worked magnificently against the German dive-bombers, which were causing such havoc among the troops on the ground.

A dive-bomber, to be effective, has to keep his eyes fixed on his mark. He must not deviate from a straight line. Consequently when the Defiant came across dive-bombers in action, pilots used to close in sideways till the two machines were flying side by side. Then the four guns of the Defiant poured in a broadside which, in the words of one of the gunners, 'blew the belly out of the bomber'.

The destruction among the German bombers by the Defiants during that surprise attack was astonishing. But after a while the Germans got wise to them and the effect was not so marked. Also, although the Defiant was very good against dive-bombers, which have to dive with their air brakes on, to avoid diving into the ground, it was not fast enough to compete with the later German fighters and bomber-fighters, such as the Messerschmitt 110. If it came in contact with

them, the turret became a purely defensive organization. Consequently, its usefulness was found to be limited, and since its exploits in Flanders it has been used very judiciously.

I imagine that it would be found useful in the Middle East against Italian machines, which are not so wonderfully fast, and against the German dive-bombers that are being used in the Sicilian Straits and against our ground troops.

Whatever may be the future of the Defiant, it has justified its existence, and all the trouble and expense of production, by those brilliant actions in Flanders. And now we have been told by the B.B.C. and by Air Ministry communiqués that it is being used as a night-fighter.

This, I believe, is reversion to type, in that the Defiant was originally designed to be a night-fighter.

Chapter 19

THE WESTLAND WHIRLWIND

Away back in the early days of gas-engines, when internal-combustion engines were beginning to cut into the steam-engine business, and oil-engines were just starting to prove themselves a commercial proposition, the firm of Petter & Sons Ltd. came into existence at Yeovil in Somerset—not a very probable place for an engineering undertaking, for it is far from supplies of raw material. Its advantage was that it was right alongside the London & South-Western main line from London to Exeter, and also close to the north-south lines from Bournemouth and Weymouth to Bath, Bristol, and Birmingham.

The Petter firm specialized on smallish oil-engines for agricultural work—driving dynamos for house-lighting and so forth. The idea was that importing raw material and turning out the finished article close to its market in the great agricultural West Country was a better business proposition than making the engines in the iron-and-coal areas and having to pay heavy freights on long hauls to the market.

Anyhow, the Petter business prospered exceedingly, and by 1914 the Petter oil-electric plant was one of the best known in the world.

By 1915, when the last war was going strong and the Admiralty and War Office were looking round for engineering firms to make aeroplanes for them, the keen naval engineers

under Commodore Sueter spotted Petters as a likely source of supply, and a deal was made. Mr. (temporary Lieutenant, R.N.V.R.) Robert Bruce, an Admiralty Inspector of Aircraft, who had been chief engineer to the famous Mr. Brennan's monorail, his controlled torpedo, and his helicopter, was sent down to show Petters how to build Short seaplanes.

So well did Robert Bruce do his job that soon Petter-built seaplanes, produced at the Westland Works, were among the most highly esteemed in the Royal Naval Air Service. And so highly did the Petter brothers, who were the joint heads of the firm, think of Robert Bruce that he remained chief of the Westland Works for about twenty years, and only retired because he thought that he deserved a rest.

The solid, conscientious work of the West Country mechanics, coupled with their pride in Petters' reputation, and guided by Robert Bruce's skill and experience, turned out fine aeroplanes after the War of 1914–18. To the firm was then given the thankless job of taking the good little D.H.9, designed by Geoffrey de Havilland for a 230 h.p. Siddeley Puma motor, stiffening it up and enlarging it to carry, and to be hauled along by, an American Liberty motor of an alleged 450 h.p. To Petters' credit be it said, they made as good a job as anybody could have made of such a hotch-potch.

The machine was called the D.H.9a—or the Nine-Ack, for short—among the R.A.F. folk. It always reminded me of old M. Panhard's saying, when someone remarked that the gear-box of a motor-car was only the back-gear of a lathe inside an aluminium box: 'It is brutal, but it works.'

The old Nine-Ack, which the R.A.F. used to load up like a Christmas tree, with everything from spare wheels to cases of beer slung under the wings and fuselage, was the 'general slavey' of the Air Force for most of ten years. And it was superseded by the Westland Wapiti, which had the Bristol

Jupiter motor, and was just as brutally overloaded and ill-used—a sort of 'commissariat camuel', as Kipling said. I believe that they still use Wapitis in out-of-the-way stations in India, for the training of native pilots.

After that came the Westland Wallace, a very refined Wapiti. It has a conservatory over the crew, a Pegasus motor, and various refinements. Just before the war, in 1939, the Ulster Squadron of the Auxiliary Air Force, formerly a Special Reserve Squadron, had them.

In the meantime, in July 1935, the Westland Works were taken over from Petters Ltd. and were floated on the public as Westland Aircraft Ltd., by Mr. A. P. Good, who is now a director of the firm. Lord Aberconway is Chairman, Mr. Eric Mensforth is Managing Director, and among the other directors are Sir Holberry Mensforth, Sir Felix Pole, and Air Vice-Marshal McEwen, C.B., C.M.G., D.S.O., R.A.F. (rtd.)—a very impressive board. And the Petter connection survives in Mr. W. E. W. Petter, B.A., A.F.R.Ae.S., who is the Technical Director.

Young Mr. Petter is a grandson of the founder of the firm and son of Sir Ernest Petter, who was the Chairman until the floatation. He had studied engineering at Cambridge and came into the Westland Works when he left the university.

He first attracted attention in the aircraft trade by designing that remarkable aeroplane the Westland Lysander, specially for Army co-operation work. And for such work, as we understood it before this war and the German onslaught in France, it was excellent. In fact it has done grand work in Africa against the Italians, in low reconnaissance and in short-range bombing and ground-strafing, and most of all, in keeping closely in touch with the troops on the ground. This is not the place to discuss or describe its features or its virtues, beyond saying that, except perhaps the Handley Page Hampden heavy bomber, it is the most be-slotted and

be-flapped aeroplane in the R.A.F. And certainly, as a result, it lands shorter and climbs off sooner than anything else in the Service of its size and speed.

When the Lysander was well away as a production job Mr. Petter turned his attention to designing a very fast twin-motor fighter.

Quite early in 1939 one began to hear stories from the West Country of a small twin-motor monoplane which careered around the sky at fantastic speeds. The local yokels called it the 'Crikey', because it reminded them of the famous petrol advertisement, showing the gentleman with the swivel neck, trying to look left and look right at the same time and ejaculating, 'Crikey! That's Shell, that was!'

That gives one a notion of how fast it seemed. And there seems to be no reason why one should doubt the justice of that impression. Unfortunately, at the time of going to press one may not yet describe the machine in detail. Officially it is called the Whirlwind. Lord Beaverbrook mentioned it by name at a public affair early in December 1940—and if the Minister for Aircraft Production sees fit to make its existence public, its description in print in England cannot be long delayed.

Something like it, with much circumstantial detail, appeared in a popular American aviation paper in November, and naturally the Germans know all about that. But they do not know how much of the impressive details published are inaccurate. And until several of the type are known to be in German hands publication of accurate performance figures, or even information about the precise type of motor used, would be foolish.

We are not likely to send our newest fighters over to the Continent to be shot down or to make an accidental descent. They can do all the needed experimental flying against the enemy on this side of the water. Some Germans may see them

and live to take a mental snapshot of them back to Germany. Probably competent authorities from the office of the Air Attaché at the German Embassy in London saw the 'Crikey' disporting itself round Yeovil in 1939. But they cannot have got a detailed specification, or present figures for speed and climb, or a description of the armament that is now carried. All of which differ materially from those of the original 'Crikey.'

So, all we can say here is that the Whirlwind deserves its name, and that it is very fast indeed.

PART IV

AERO-MOTORS

Chapter 20

THE QUALITIES OF AERO-MOTORS

Before starting to give the pedigree of the aero-motors used in the various fighters described in the foregoing chapters, a brief review of aero-motors in general may be useful.

When men first began to fly, they tried to do so with car engines. Some of those who were clever mechanics spent much of their time whittling down existing car engines to get them as light as possible. One of the experimenters remarked to me at the time, 'At the finish, we were getting the weight off with a smooth file,' meaning that anything other than a smooth file would have gone right through certain places where they had lightened component parts to the utmost limit.

The Wright Brothers, who, in 1903, were definitely the first men to fly, built themselves a little four-cylinder motor that was in effect an ordinary car motor not much lighter than a good many existing motors. And it did not give much more power per pound weight. They got their machine into the air with a catapault apparatus, and so showed us the way to get overloaded machines off by what is officially known as assisted take-off.

At about the same time one Manley, of the Smithsonian Institute, Washington, working with Professor Samuel Pierpoint Langley, of that Institute, on the 'Langley Aerodrome' (meaning air-runner, or flying machine), built a five-cylinder

air-cooled stationary radial motor, which gave about 50 h.p. and did in fact fly the machine when it was strengthened-up by Glenn Curtiss in 1914, after Langley's death.

Glenn Curtiss, who was the great rival of the Wright Brothers and had done much motor-bicycle racing, likewise flew his early machines with car-type engines, which he had built himself, in conjunction with Dr. Graham Bell (of the Edison Bell Company), J. A. D. McCurdy and 'Casey' Baldwin (both Canadians), and Lieutenant Selfridge of the U.S. Army. Unfortunately for the Wright Brothers, their aeroplane turned out to be a dead-end design, whereas the Curtiss aeroplanes, the first of which got off the ground under its own power, without a catapault, became important weapons in the War of 1914–18.

While the Wrights and Curtiss were experimenting in America many people were experimenting in Europe.

A Dane named Ellehammer managed to get an aeroplane off the ground for a short hop some time in 1907, before anybody else in Europe. He used a car-type engine of his own design and make.

Santos Dumont, a quaint and wealthy little Brazilian, who spent his life in Paris, started experimenting with little airships, and ultimately built an odd little aeroplane made up of a series of box-kites. It had a motor developed from motor-cycle practice. To him is generally given the credit of being the first man to fly in Europe.

Then in 1908–9 came that remarkable mechanical device called the Gnôme rotary motor. Why it was so called is uncertain, but the common belief was that the Séguin Brothers, the inventors, called it so because the gnomes were supposed to do all the hard work in the halls of the Mountain Kings, wherever they existed in legend.

The earliest type had seven cylinders. The crank-shaft stood still, petrol and oil were injected with air into the crank-

shaft, and the mixture was admitted through a valve in each piston into the combustion-chamber.

Everything about the engine was odd, but about the oddest thing was that the cylinders were made of steel, instead of cast-iron, and instead of piston-rings in the ordinary sense, the pistons had what were called obturator rings, made of brass, and ultimately of silver, which acted like the leather pump-buckets of an ordinary air-pump, and prevented the flame inside the cylinders from getting down outside the piston-rings and blowing up the crank-case.

Just why the Séguin Brothers chose to make it a rotary, instead of keeping the pistons standing still and letting the crank-shaft go round in the normal way, I have never discovered. The only explanation of its rotariness seems to be that they wanted a big flywheel effect without the idle weight of a flywheel, and so thought of buzzing the whole engine round, to be its own flywheel.

The fact remains that after the War of 1914–18 an ingenious person in the United States bought up a heap of old rotary motors at a very low price, and transformed them into quite good stationary radial motors, such as are used commonly on the majority of aeroplanes to-day, in which the air-screw gives the needed flywheel effect.

Anyhow, the Gnôme Motor was so much lighter than anything else in the world that, in the common phrase of the period, 'it would make a tea-tray fly'. The result was that many different types of aeroplanes were persuaded dangerously into the air which would never have got off the ground with any existing form of aero-motor.

While the Séguins were enabling Frenchmen to fly, M. Anzani, an Italian Frenchman, who was famous in motor-cycle racing, did try to produce a stationary radial motor. But instead of having steel cylinders, as the Séguin Brothers motor had, he stuck to the old-fashioned cast-iron cylinders,

which made his engines much heavier, and many cylinders blew off when he tried to make them lighter.

Nevertheless, one of these absurd little Anzani motors with three cylinders, which gave a doubtful 28 h.p., managed to keep M. Louis Blériot in the air from Calais to Dover in July 1909. Hence the classic phrase or platitude, demonstrated for the first time that day, that Britain was no longer an island—as we painfully realize in these days.

Soon the lightness of the Gnôme put it far ahead of anything else in France and enabled the later Blériot and Farman, and many other machines, to do quite great flights.

One milestone in the road of progress was the achievement of Marcel Prévost, who in 1913, in a Deperdussin monoplane with a double-row Gnôme motor, with eighteen cylinders and an alleged 200 h.p., covered just over 120 miles in the hour, near Reims. That was the first time that a human being had done two miles a minute for an hour on end.

The Gnôme Motor was soon followed by the Le Rhône, and by the Clérgêt, which were rotary motors but worked their intake and exhaust valves differently.

The irony of fate was exemplified years later, when, after the Gnôme and Le Rhône Company had amalgamated, and Clérgêt had been squeezed practically out of business, the rotary motor fell into disfavour and the Gnôme-Rhône Company kept itself alive and ultimately made a vast fortune by buying a licence from the British Bristol Company to make stationary radial motors designed by Mr. Roy Fedden, of whom more will be said in a following chapter.

At the other end of the scale, the Germans, instead of making aeroplanes fly with phenomenally light motors, worked away steadily to improve their aeroplanes so that they would take heavy water-cooled motors into the air. The Canstatt-Daimler Company, which was making the Mercédés car, had the reputation of doing magnificent work

in motor-cars. In those days, the world's greatest motor event was the French Grand Prix, and for years these races had been fought out between the German Mercédés, the Italian Fiats and Italas, and a few big French firms such as Panhard-Levassor, Peugeot, and Lorraine-de-Diétrich—the names make music to any old-time motorist. And, be it said, the men who ran those firms in those days were great sportsmen and great gentlemen.

The two German firms that made the best aero-motors were the Mercédés people and the Benz. And right through the War of 1914–18 those two firms fought for the lead in the German aero-motor industry. To-day Daimler-Benz, a combination of the two, provides the motors for the majority of German aeroplanes, at any rate for their high-speed fighters.

So well did the Germans develop their heavy but highly efficient motors that in the summer before the outbreak of war in 1914 one German aviator, Rudolf Boehm, had flown for a little more than twenty-four hours non-stop—24 hours 8 minutes, I believe. Another, Landmann, had taken one of their heavy biplanes up to 22,000 feet. And a third, Suvelack, had flown with a passenger from the Johannisthal Aerodrome, Berlin, to Eggri Palanka, on the frontier of Turkey, 1,000 miles non-stop. Believe it or not. Those would have been good flights twenty-six years later.

During the war, the Germans did make air-cooled motors that were more or less copies of the French Gnôme. But they never did much with them. They were mostly used in light, short-range fighters. Their really great fighting machines, the Albatross and the Fokker, in its later types, and all their big bombers, had water-cooled motors.

We in this country were divided in our affections. We made, under licence, copies of the Gnôme and the Clérgêt and the Le Rhône. Some of them were better than the French originals, some of them were much worse. People in the

R.F.C. and the R.N.A.S., and later the R.A.F., when they saw the names of certain firms on engines, used surreptitiously to let out the oil, or turn off the oil supply, and let the engines run themselves to destruction on the ground, because they knew that if they ever took off with them, they would probably themselves find destruction on the ground.

Before the last war the great engineering firm of Beardmore on the Clyde had started to make the Austro-Daimler aero-motor under licence. The Austro-Daimler was never as good as the Mercédès or the Benz, but it was a beautiful piece of work. And the Beardmore version of it did excellent service during the earlier years of the war. But the engines that did best for us in the air from 1916 onwards were certainly the Rolls-Royce in its two types, the Falcon, as used in the Bristol Fighter, and the Eagle, which was used in the big bombers and in our flying-boats.

I may mention here two engines which at the very end of the war looked like doing something wonderful. One was the Bentley Rotary, an improvement on the Gnôme-Rhône-Clérgêt type, which was designed by Mr. O. E. Bentley, who later became world-famous as the designer of Bentley cars, and is now concerned with the Rolls-Bentley cars. The other was called the A.B.C. Dragonfly, and made by the A.B.C. Engineering Company of Hersham, near Brooklands. It was the first of the comparatively high-powered stationary radial motors, and was designed by Mr. Granville Bradshaw. It was designed in a hurry, and built in a hurry, but it gave terrific power for its weight. The trouble was that, as it was developed so quickly, there was no time in which, as the Americans say, 'to get the bugs out of it'.

Harry Hawker, the test pilot of the Sopwith Company, whose name is memorialized in Hawker Aircraft, told me, when he had flown a Sopwith Snipe with a Dragonfly in it, that it was a new sensation in flying. Instead of having to do

all kinds of tricks with the controls to counteract the frightful gyroscopic effect of the big rotary engines, the machine just went where the pilot put it. He said that having the stationary radial instead of the rotary made flying 50 per cent easier.

Towards the end of the war, when things looked like going on for another five years, and Lord Weir was Air Minister, a decision had to be made about standardization of big motors for fighters. At that time the Dragonfly would just about hold together for $2\frac{1}{2}$ hours' hard flying and fighting on patrol. So Lord Weir, greatly daring, ordered thousands of them.

He explained to me, shortly after he had done so, that a fighter patrol lasted for two and a half hours, and if the engine also lasted for two and a half hours most of the pilots would get home. After that, the engine could be taken straight out of the machine and another one put in, while the first engine was pulled to pieces for overhaul.

He very shrewdly judged that having such a phenomenally light, powerful engine would give our fighters such an advantage over the enemy that if the engine only held together for two and a half hours it would have justified its existence.

Unfortunately for the Dragonfly and the A.B.C. Company, war stopped before the engine was developed. The Air Force was cut down to 10 per cent of its war-time strength, and the whole aircraft industry collapsed under us. So the A.B.C. Company dropped making aero-motors, nobody developed the Dragonfly, and that was that.

Not until the Bristol Company absorbed Mr. Roy Fedden and the Cosmos-Jupiter aero-motor did we come back to fixed radials. The story of development of the Bristol motors and of the Rolls-Royce motors, that is of the air-cooled and liquid-cooled types, will be found in the following chapters.

I fear to tread on the debatable question whether air-cooled

or liquid-cooled motors are really the best. I once asked a famous aircraft manufacturer whether he liked the single-row Jupiters or the double-row Siddeley motors the better. His answer was that it all depended on whether you prefer sunflowers or cauliflowers. His own taste ran to the water-cooled type.

On the other hand, there is no doubt that by the time you have taken in the weight of radiators, water, and everything else, the air-cooled radial is the lighter motor. Against that, the in-line engines, whether V-type, X-type, or H-type, do get more power into a smaller frontal area than can be got with a radial. But one of the greatest of our aircraft designers shares with me the belief that we are far from seeing the end of the air-cooled motor, and that there are great possibilities in a flat twelve-cylinder air-cooled motor with two opposed rows of six cylinders, built right inside the wings of big bombers or flying-boats or air liners.

A water-cooled engine of this type was shown for several years at the Paris Aero Show without anybody being interested in it. The aforementioned great designer got out a general lay-out of such an engine and showed it to the British aircraft industry. Nobody was interested in it. Within the past twelve months my friend Val Cronstedt, of the Lycoming Company, U.S.A., has built and has tested thoroughly an air-cooled flat 12 of something over 1,000 h.p. We now have to wait and see whether the American aircraft industry will build the right sort of aeroplane to use it. Possibly along those lines may be the next big development.

One might argue for ever about the respective merits of in-line and radial motors, and of liquid-cooling and air-cooling. The motor manufacturers themselves seem singularly free from prejudice on the method of cooling. One of the most important makers of liquid-cooled engines has experimented with air-cooling on big motors, and the makers of

successful air-cooled engines have produced a large liquid-cooled engine.

The standard argument of the air-coolers is that carrying pounds and pounds of water and radiators and consequent plumbing through the air just to take a bit of heat off a cylinder-wall, is silly. The liquid-coolers retort that they will give up liquid-cooling as soon as the air-coolers can get as much power out of a super-charged super-compressed cylinder as they can. The answer to that is that one has to cart so much weight about and waste so much power in pushing radiators through the air that the extra power that one gets out of a liquid-cooled cylinder is all spent in carting and pushing the gadgetry.

Also there is the argument that all the radiators and consequent plumbing of liquid-cooling are something else to be hit by enemy bullets, and that a liquid-cooled engine, after the liquid has leaked out through a bullet hole, does not lubricate really well on molten bearing-metal.

Apart from that there is the argument that in-line motors set up less head-resistance than do sunflowers or cauliflowers, as is proven by the fact that all the fastest aeroplanes for years, and all the record-breakers, have had in-line liquid-cooled motors.

On the other hand, as air-cooled radials have much shorter crankshafts, they decrease the longitudinal moment of inertia of the machines in which they are fitted, by comparison with the long crankshafts and snouts of the in-line types, and so make the machines notably quicker on their controls and so more manœuvrable in a fight.

The liquid-coolers' answer is that there is no use in manœuvring quickly if one's machine is so slow that one cannot break off a dogfight and go home undisturbed.

So you see the argument boils down to 'you pays your money, and takes your choice'.

Chapter 21

THE PEDIGREE OF THE BRISTOL MERCURY

In or about 1910–11, when Major Lindsay Lloyd—lately deceased and much regretted—was turning the space inside the Brooklands Motor Track into an aerodrome, with the cordial assent of the sporting owners, Mr. and Mrs. Locke-King, we who were in aviation took a mild and friendly interest in the people who used to hurtle noisily and perilously round the track in racing cars, while we—that is to say, such people as Tommy Sopwith, Martin and Handasyde, Howard Wright, and R. F. Macfie (who in 1914 invented the war-tank)—got along peacefuly on our then restricted area with the job of trying to coax motor-driven mechanisms into the air—I cannot call them aeroplanes or flying-machines, because so few flew.

Among those car-racing folk was a young man from Bristol, A. H. R. Fedden—Roy Fedden to his friends. He drove a very smart and speedy make of car called the Straker-Squire. It was not one of the great classic racing cars, such as the Fiat, or Napier, or Mercédés, of that day, because it was primarily a touring car, and those Roy Fedden drove were modified to his own designs for speed work.

He used to come round off the track to look at our queer vehicles, and the still stranger motors with which they sometimes flew. Fedden was a first-class engineer, even then, and

no doubt wondered, as many of us did, then and for most of ten years afterwards, why to fly fairly decently an aeroplane had to have a matter of 200 lb. of steel whirling round in front of its nose, and setting up a hideously dangerous gyroscopic effect.

In those days practically every aeroplane that flew for any distance or at any speed, as we understand speed, had a rotary engine—a Gnôme at first, and then later a le Rhône or a Clérgêt. We learned all our aviation, and a lot of our air language, from France—hence *fuselage* and *aileron* and *hangar*, which we still use to-day. So we thought that whatever engines the French used must be the right thing.

Only the Germans had the sense to modify car engines and force their aeroplanes to lift them. Which was why the Benz and Mercédés-Daimler car firms had good aero-engines ready for war in 1914, and we had none. Which, also, is why, before war broke out, in August 1914, the German engines had set up the records already mentioned.

Be that as it may, when war started the firm which made the Straker-Squire car—Brazil, Straker & Company Ltd., somewhere up Fishponds way outside Bristol—went in for making munitions. And Roy Fedden turned his engineering ability on to the job.

But after a while, when the need for better and lighter engines became more and more evident, I suppose that he wondered more and more why nine or eighteen great cylinders should whirl round their own crankshaft, carrying an airscrew on their crank-case, when a much more logical and less gyroscopic method would be to keep the cylinders still and buzz the crank-shaft round, with the airscrew on it.

How bad that gyroscopic effect was may be judged by the fact that in a Sopwith Camel, which had a very short fuselage and was therefore snappy in its movements, one did a right-hand turn with full left rudder. The turn to the right,

with a steep bank, precessed the gyroscope so that it tried to throw the nose of the machine down, and one had to hold the nose up with full rudder to the left. If one did not one got into a violent right-hand spin. Dozens, if not hundreds, of pupils and young pilots were killed that way—see Elliott White Springs' stories in *War Birds*.

Anyhow, Roy Fedden wanted to make a fixed-cylinder, radial motor. Philip Brazil, the chief of Brazil-Straker's, agreed that he should have a try at it. So the Cosmos Engineering Company Ltd. was started. And the result was the Cosmos-Jupiter motor—a nine-cylinder job which gave some 300 h.p.

Developing any complicated mechanism is a long job. And developing an aero-motor is one of the longest. Designing the engine is simple enough, on the drawing-board. And if one is not particular about weight one may hope to produce a heavy and reliable machine which will not break down. But when one starts out with the idea of getting down to 1 lb. per h.p., and less than that if possible, then one is looknning for trouble.

In 1917–18 we had not the special steels and high-duty aluminium and magnesium alloys we have to-day, and working parts of normal high-grade steel and ordinary aluminium were a lot bigger and heavier than they would be now.

And then, when one has got the design down to weight by calculation and has built the first engine, the trouble really begins. 'Getting the bugs out' of an engine is the most heartbreaking job of the lot. One runs a test and something breaks, or a bearing goes, or a cylinder runs hot, and the whole thing has to be 'taken abroad', as they say in Devonshire.

When the defect is found it may be a fault in the design or in the material. Or it may be sheer accident—I *have* known a mechanic to leave a spanner in a crankcase, and I *have*

known a mechanic to wrench the top of a bolt so that it cracked and broke after a few hours' running

I have known a new type of engine, running its last acceptance test of 150 hours non-stop for the Air Ministry, crack up through no fault of its own within ten minutes of the end of the test. If I remember rightly it happened through some mishap to the local water-supply.

In 1917–18 nobody knew as much about designing and testing aero-motors as we do now, and young Mr. Fedden had everything to learn in those days. To-day there is not much left for him to learn. In all the numerous and diverse types of engines he has built he must have seen every possible permutation and combination of mishaps. Which is probably why, in these days, Bristol aero-motors go through their tests comparatively peacefully.

At the end of the war in 1918 the Cosmos-Jupiter was full of promise, but had not had time to give much performance. And then, in 1920, when so many people thought that we were in for a great peace boom in aviation, the inevitable post-war slump hit us, and everything to do with flying went as flat as a packed-up engine. The Cosmos-Jupiter went flat too.

Roy Fedden, knowing that he had a good thing, looked round for a firm that was big enough mentally and financially to see the Jupiter through its mechanical teething troubles and through the financial slump. He was lucky, for he found that the directors of the Bristol Aeroplane Company Ltd. (which in its early days had been the British & Colonial Aeroplane Company Ltd.) were game to back him.

At that time Mr. Samuel White had succeeded his late brother, the great Sir George White, as chairman of the firm. His nephew, Sir Stanley White was managing director, and Sir George's nephews, Mr. Verdon Smith and Colonel

Sidney Smith, were on the board, as was Mr. Herbert Thomas, a relative of Lady White's. Sir Henry White-Smith, brother of Colonel Sidney Smith and Mrs. Verdon Smith, was chairman of the Society of British Aircraft Constructors. He also was an enthusiastic supporter of the Jupiter proposition. So Mr. Fedden had the best of backing.

How much the Bristol Company has spent on developing the various types of aero-motors Mr. Fedden and his brilliant staff have designed might be learned by laborious researches into 'Development and Experimental Charges' in Bristol balance-sheets of the past twenty years. But by now the amount must run into something nearer millions than hundreds of thousands of pounds.

What with special machinery, special buildings, laboratories, test-benches, and all the equipment of one of the most perfect workshops in the world, enormous sums must have been spent. And the money has been well spent, for the work the Bristol engines have done in this war alone justifies it all and more.

The Cosmos-Jupiter developed into the Bristol Jupiter, which was used in many types of R.A.F. machines, notably the Westland Wapiti and the Boulton-Paul Sidestrand, and in civil aeroplanes, particularly the Hannibal class of Handley Pages used by Imperial Airways, for years.

From it the Pegasus was developed. The Mercury is of the same design but an inch shorter in stroke and four inches less in diameter. Also it is lighter. For these, and other more technical reasons, the Mercury was chosen for use in the Blenheims and in the Gladiators.

This bit of history is properly concerned with the pedigree of the Mercury. But a note on the progeny of the Jupiter, Pegasus, and Mercury seems only fair. So long ago as 1926 Roy Fedden and his directors foresaw that sooner or later speed and load in high performance engines would find the

limit for overhead valves operated by push-rods, and would call for more and more care and maintenance. So they turned to the single-sleeve, or cuff, valve originally produced under the Burt-McCallum patents of 1908 or thereabouts.

The system had been used in cars by the Argyll Motor Company and in motor-bicycles by Barr & Stroud, both in Scotland. But in those early days neither steels nor machine-tools nor knowledge nor research were adequate to develop the system thoroughly.

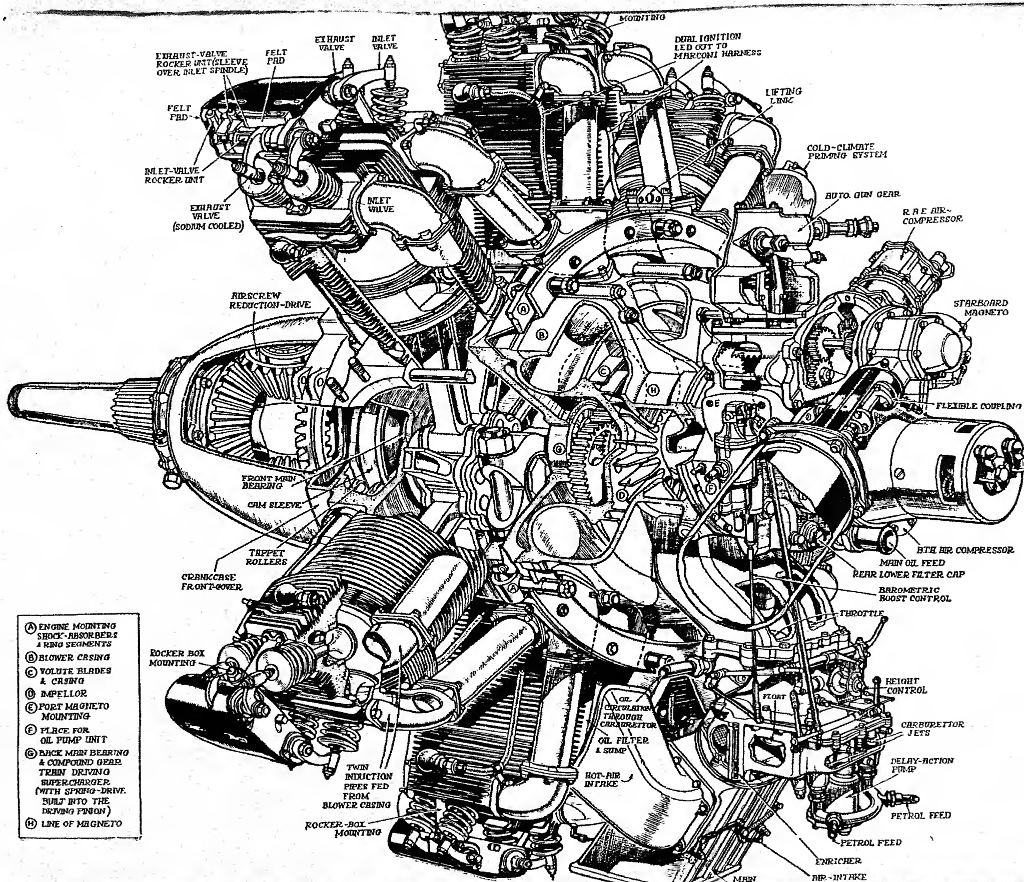
The enormous resources of the Bristol Company beat the problems involved, and in 1932 the first radial air-cooled sleeve-valve aero-motor was produced. It had nine cylinders and was called the Perseus. After thorough tests on the bench and in the air it was put into production. It gave 700 h.p.

In 1936, the Hercules, an engine on the same principle, with fourteen cylinders, in two banks of seven each, was produced. It gave 1,375 h.p. maximum power, and was at that time the most powerful air-cooled motor in the world. To-day it is only surpassed (not beaten) by a bigger and heavier American engine with eighteen cylinders.

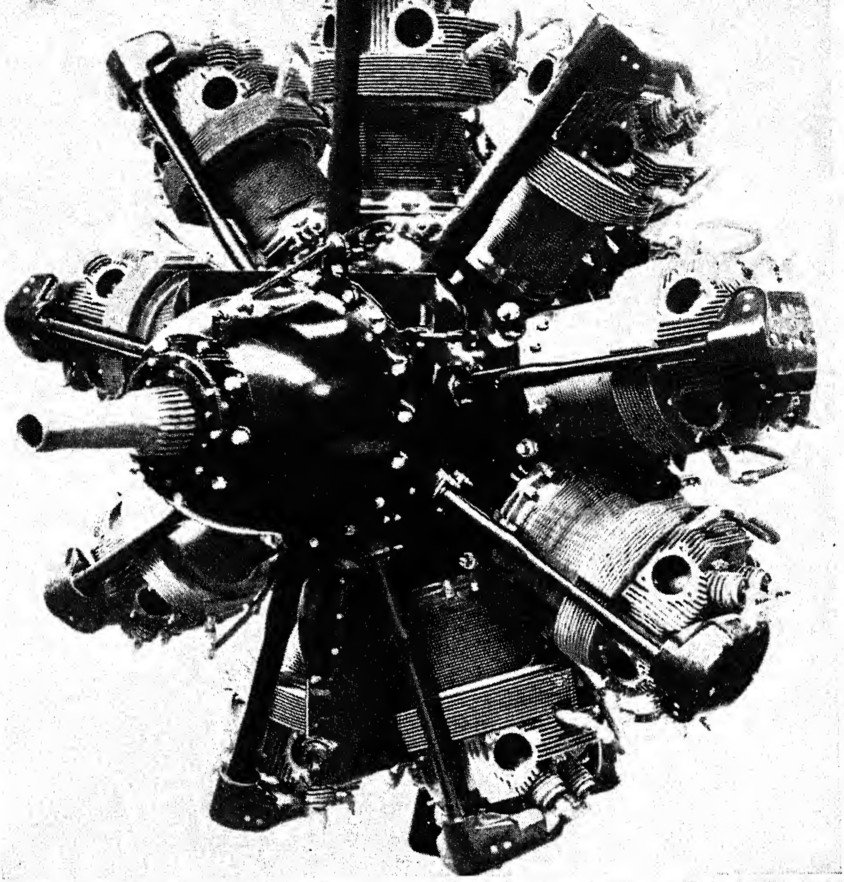
The development of these entirely new types of engines and the installation of special machinery for their manufacture in quantities meant still more heavy outlay of capital, but the board of the Bristol Company did not hesitate. In the fine spirit of the Bristol merchant venturers, who centuries ago built the City of Bristol out of the risks they and their ships took in ventures all over the oceans of the world, so the Bristol Aeroplane Company backed with hard cash their judgement of what was needed for success in the air. The present board has proved itself worthy of the founder of the firm, Sir George White, whose services to British aviation can never be fully recognized.

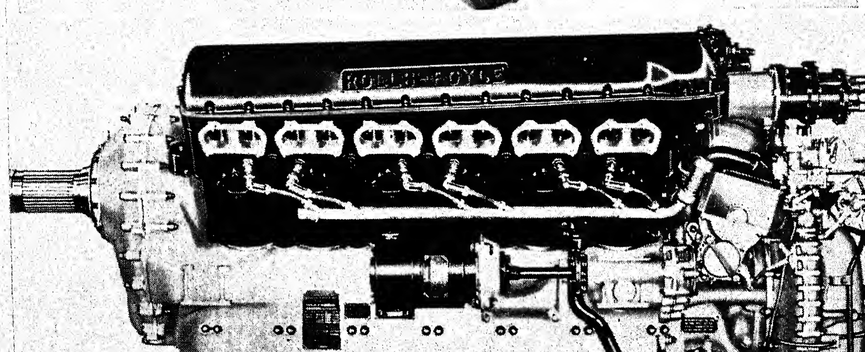
I mention these sleeve-valve engines gratuitously, for they are not used in any of our fighters. But they mark an advance in general design which may lead to great developments and so deserve the notice of those who are keenly interested in our war-machines.

Plate 9. Bristol Mercury engine



MOUNTING
DUAL IGNITION LED OUT TO MARCONI HARNESS
EXHAUST VALVE
INLET VALVE
EXHAUST-VALVE ROCKER UNIT (SLEEVE OVER INLET SPINDLE)
FELT PAD
FELT PAD
LIFTING LINK
INLET-VALVE ROCKER UNIT
COLD-CLIMATE PRIMING SYSTEM
EXHAUST VALVE (SODIUM COOLED)
INLET VALVE
AUTO. GUN GEAR
R.A.E. AIR-COMPRESSOR
AIRSCREW REDUCTION-DRIVE
STARBOARD MAGNETO
FLEXIBLE COUPLING
FRONT MAIN BEARING
CAM SLEEVE
TAPPET ROLLERS
CRANKCASE FRONT-COVER
BTH AIR COMPRESSOR
MAIN OIL FEED
REAR LOWER FILTER CAP
BAROMETRIC BOOST CONTROL
THROTTLE
ROCKER BOX MOUNTING
FLOAT
HEIGHT CONTROL
OIL CIRCULATION THROUGH CARBURETTOR
CARBURETTOR JETS
OIL FILTER & SUMP
DELAY-ACTION PUMP
TWIN INDUCTION PIPES FED FROM BLOWER CASING
HOT-AIR INTAKE
PETROL FEED
ROCKER-BOX MOUNTING
PETROL FEED
ENRICHER
MAIN
AIR-INTAKE
(A) ENGINE MOUNTING SHOCK-ABSORBERS & RING SEGMENTS
(B) BLOWER CASING
(C) VOLUTE BLADES & CASING
(D) IMPELLOR
(E) PORT MAGNETO MOUNTING
(F) PLACE FOR OIL PUMP UNIT
(G) BACK MAIN BEARING & COMPOUND GEAR TRAIN DRIVING SUPERCHARGER (WITH SPRING-DRIVE BUILT INTO THE DRIVING PINION)
(H) LINE OF MAGNETO




ROLLS-ROYCE

Chapter 22

THE PEDIGREE OF THE ROLLS-ROYCE MERLIN

Somewhere in the Dark Ages of self-controlled locomotion, as distinct from co-operative locomotion on railways, a young man at Oxford University took to riding a bicycle. It was not 'done' at all in those days. Only low fellows of the baser sort, such as clerks and shop-keepers, rode bicycles, for this was before the Society boom in cycling of 1897–8, when everybody was doing it. But the young man happened to be the Honourable Charles Rolls, son of Lord Llangattock, of Monmouth, so much was forgiven him.

Charles Rolls pushed his bicycle very hard and rather fast. In fact he rode in cycle races—which gave his contemporaries at the university the idea that he was a bit queer. But pushing a bicycle fast was, and still is, the nearest thing to flying, as a sensation, that I know. And perhaps that gave Rolls his great idea.

When motor-cars became the fashion Charles Rolls, who could afford luxuries, went in for those too. I remember him well driving a big French Mors car in the series of sprint races that followed the Gordon-Bennett race in Ireland in 1903.

But the motor-cars of those days, French, British, or American, were not good enough for Charles Rolls. He loved everything mechanical, but he hated the 'get out and

Plate 10. Bristol Mercury and Rolls-Royce Merlin

get under' process, which was part of every motor trip of those days. Working parts wore out and other things came unput too often for comfort or fast journeys. So Rolls made up his mind to get somebody to make the perfect car with the perfect motor.

In 1904 he was introduced by Henry Edmunds, a prominent member of the Automobile Club—not yet Royal—to Frederick Henry Royce, who made electric cranes near Manchester, and had made an experimental motor-car in 1903. Rolls and Royce agreed that there was money in the perfect car—apart from the service that would be done to British business by setting up a standard of material, workmanship and finish such as no other car-maker had attempted, let alone achieved. But the idea can never have struck Rolls or Royce that their names combined would become an adjective in world-wide use to signify superlative excellence in manufacture or the highest degree of luxury in living. Anyhow, Charles Rolls and Claude Johnson, his partner in C. S. Rolls & Company, automobile agents in London, linked up with F. H. Royce of Manchester.

And, by the way, you folk who flatter yourselves that you know something about cars—do you know that one of the first Rolls-Royce cars had three cylinders? The crankshaft had its crank-throws set at 120 degrees to one another, just like the crankshaft of a six-cylinder engine. It ran like silk, but the impulses were rather few and far between, because it was a slow-running engine, and, as it had only three cylinders it only gave one and a half explosions per revolution—work that out for yourselves. The last of those cars that I saw, about six or seven years ago, was recognizably Rolls-Royce in the lines of its bonnet and radiator, and in its exquisite workmanship.

When people foolishly began to fly, in 1908, Charles Rolls took to the new sport as a natural step beyond motoring. He

bought a quaint biplane in 1909 from Short Brothers—now famous for their vast Sunderland flying-boats, but then official balloon-makers to the Aero Club of Great Britain, now the Royal Aero Club.

At that time they made balloons in a railway arch near the Dogs' Home at Battersea, and tried to make aeroplanes on a marsh at Leysdown on the Isle of Sheppey. A year or so later they moved to what is still the Eastchurch Aerodrome. In those early days the Shorts hooked up with the Wright Brothers, Wilbur and Orville, the first men to fly. Quaint, isn't it, when you come to think of it, in these days of trans-Atlantic and trans-Pacific flying, and of bomb-raids on cities a thousand miles away, that the first man who ever flew, little Orville Wright, is still alive. He is only about seventy, if that.

Anyhow, Charles Rolls bought a Wright biplane, and then in 1910, he bought a French-built Wright, which broke in his hand when flying in a competition at Bournemouth and killed him.

But by that time the Rolls-Royce car had already reached so far towards perfection that it represented the high limit of quality. And it kept there. Henry Royce saw to that. So did Claude Johnson, the managing director, who was more responsible than anybody for getting the Rolls-Royce cars in with all the best people.

Soon after war broke out in 1914, somebody in the Department of Naval Aviation at the Admiralty had the brilliant idea that, as there were no good British aero-motors in those days—we had plenty later on—the Rolls-Royce people would probably be able to fill the gap. And they were right.

The first Rolls-Royce aero-motor was a little, six-cylinder, water-cooled job for a small airship—the Royal Naval Air Service ran excellent anti-submarine patrols with Blimps—so

named by Horace Short, who, when asked why, replied, 'Well, what else *could* you call them?'

The original Blimp was an aeroplane of 80 h.p., complete, but minus wings, slung underneath a stream-lined gas-bag. From that developed proper little single-motor non-rigid airships of 120 h.p., and in these, and in later twin-motor types the first Rolls-Royce aero-motors did splendidly.

From these little single-row motors the Rolls-Royce Company developed the remarkable Falcon of 275 h.p. and the Eagle of 360 h.p.—both water-cooled, twelve-cylinder engines, with two banks of six cylinders in Vee form. Each cylinder was separate from the others, and had its own water-jacket, which meant a lot of plumbing.

The Falcon was used in the Bristol Fighter, a two-seater, in which the gunner sat back-to-back with the pilot, and had twin Lewis guns on a Scarff ring. It first came into use at Easter 1917, and did much to give the Royal Flying Corps by the end of the year the command of the air we held right up to the end of the war.

The Eagle was used in the Handley Page twin-engined bomber, which was the first British heavy bomber. It was developed to the order of the Royal Naval Air Service, through the initiative of Commodore Murray Sueter, R.N.—now Rear-Admiral Sir Murray Sueter, M.P. Towards the end of the war the Handley Page V/1500 was produced, which had four Eagles, and a gunner in the extreme end of the tail. It was designed to bomb Berlin from Norfolk.

Also the Eagle was used in the F.E.2d—a big, single-engined two-seat 'pusher' biplane, which carried a gunner perched out in the nose.

The Eagle did excellent work in the big twin-engined flying-boats that patrolled the North Sea and other coastal waters so effectively. And it was used later in the Vickers Vimy twin-engined bombers.

In all this work the Rolls-Royce aero-motors won the confidence of those who had to fly with them, and increased the high repute that the Rolls-Royce cars had built up.

After the War of 1914–18, the Falcon was used for years in the Bristol Fighters, which became the R.A.F.'s general-purpose machine, or maid-of-all-work, in India and 'Iraq. And the Eagle went on working in the Handley Page bombers.

In a Handley Page two Eagles made the first flight from England to India. And in a Vimy two Eagles made the first flight to Australia and the first non-stop flight across the Atlantic.

All this time Henry Royce was the technical genius of the firm. He had his own staff of designer-draughtsmen at his own house, away from the works at Derby, and continually worked at minor improvement and perfections.

The change from the separate cylinders to the present cylinder-block system came about in a way that deserves to be recorded.

In 1923 the Schneider Trophy Contest was flown at Cowes —odd, is it not, how almost everything in our fighters traces back to these Schneider shows? Poor little Jacques Schneider, who died in poverty in spite of the millions made out of Creusôt-Schneider guns, would be pleased to know how much we owe to his bright idea of an international speed contest for seaplanes.

To Cowes in 1923, for the Schneider Contest, came a team of American Curtiss floatplanes, as already told. These had the Curtiss D.12 motor, quite the prettiest engine of the day. It had two blocks of six cylinders each, in Vee form. The blocks were of aluminium alloy, with steel liners for each cylinder. And it had the most vicious bark of any motor heard up to that time. Something of this will be found in the chapter on the Supermarine Spitfire.

The Curtisses and their D.12's walked away with the Trophy. And we were left to think it over.

Early the next year Mr. C. R. Fairey, already one of our great aircraft manufacturers, went to America and bought the British rights to the Curtiss aeroplane designs. With them he bought the rights to the D.12 motor. And when he came back he proceeded to design and produce—as a private venture, without any Air Ministry specification—the Fairey Fox, the most beautiful two-seat reconnaissance-fighter we had seen.

It was as popular with its pilots as with the public at the R.A.F. Displays, who were thrilled by the scream of the diving Foxes. These D.12's in the Foxes started the fashion for the modern style of engine-cowling—the 'Eversharp' nose, as we called it when it was new.

At first Mr. Fairey intended to make the D.12 in this country, but, as he was primarily a maker of aeroplanes, that meant a big new venture. And in the meantime the Air Ministry was so highly impressed by the D.12 that the Staff wanted a similar British aero-motor built by an engine firm, so that it would be acceptable to all the aircraft manufacturers, which an engine built by one of their direct competitors might not be.

So Lieutenant-Colonel Rudston Fell, D.S.O., who was then in charge of engines at the Air Ministry, took the D.12, and, so to speak, said to the Rolls-Royce people, 'Now beat that.' And they proceeded to do so. They produced the Kestrel, a block-cylinder Vee engine—which was much more powerful, and lighter per horse-power, than the D.12.

Here I may note the curious fact that the Americans practically dropped water-cooled motors after the D.12. The Curtiss people made the Conqueror, a bigger engine, which was not much of a success. They did a lot of useful experimental work in liquid cooling, using ethyl-glycol instead of

water. But nearly all their airplanes had air-cooled radials until in 1935 the Allison Engineering Company developed their 1,000-h.p. twelve-cylinder Vee, and the Lycoming Company in 1938–9 developed their 'Flat-Twelve' of 1,000 h.p. which has all its cylinders horizontal, so that it can be buried in the wings of big aeroplanes.

In the meantime the Rolls-Royce liquid-cooled block-cylinder motors went ahead. The Kestrel was used with great success in all that series of Hawker aeroplanes which began with the Hart and Fury. From it the bigger Merlin was developed.

For the successful attack on the World's Speed Record after the last Schneider Trophy Contest the Merlin, using some super-octane fuel, concocted by Mr. Rodwell Banks of the Ethyl Corporation, and consisting mostly of alcohol and tetra-ethyl-lead, with, I believe a modicum of petrol, was super-charged and super-compressed up to about 3,000 h.p. and pushed those enormous floats and a miniscule fuselage through the air at a decimal more than 408 m.p.h.

To-day the standard Merlin, off the hook, as it were, from Derby or elsewhere, using ordinary 100 octane fuel, and its normal compression and supercharge, reaches about 1,100 h.p. and pushes the slim Spitfire (eight guns and all) along at something well over 400 m.p.h., and gets the bigger Hurricane along nearly as fast.

The development of the Merlin has been carried along since the death of Sir Henry Royce, by his close collaborator Mr. H. Rowledge, of the design department, in enthusiastic co-operation with the technical, experimental, and production staff at Derby, where Mr. R. T. Hives is in command.

For the way in which the horse-power of the engines and the output of the works have both grown, during the pre-war panic-expansion of the R.A.F. and during the strenuous year after war was declared, full credit is due to Mr.

A. F. Sidgreaves, who succeeded Mr. Claude Johnson as managing director. Without his business acumen and foresight in backing the policy and financing the outlay of the engineering side, we should not have had during the Blitzkrieg, the world's finest fighting engine.

And perhaps I may add here that already the Merlin is overpowered, though not outclassed in quality or efficiency, by newer Rolls-Royce products, which, in their turn will make new and still more glorious history for the Royal Air Force. Of these one may only mention the Vulture by name—no figures can be given—but obviously if it were not giving a lot more power than the Merlin, Rolls-Royce would not be making it.

PART V

SPECIFICATIONS OF THE FIGHTERS AND THEIR MOTORS

INTRODUCTORY

Here are specifications of the five standard fighters of the R.A.F., the Blenheim, the Defiant, the Gladiator, the Hurricane, and the Spitfire, which were used during the first year of the war. All were in quantity production early in 1939. Photographs of the assembly-lines of the Blenheim, Gladiator, Hurricane, and Spitfire, were published widely here and abroad, to give foreign nations and our own Dominions and Colonies an impression of the way in which we were building up our air power.

These, and similar pictures of the production of our bombers, were taken by Mr. C. A. Sims, who, for some ten years had been my Staff Photographer on *The Aeroplane*, and had taken many hundreds of flying photographs, which were recognized as unsurpassed in beauty, and showed a degree of skill that marked him as one of the two or three finest aerial photographers.

So highly were the assembly-line pictures appreciated by the Air Ministry that, on the initiative of Captain Harold Balfour, M.C., Under-Secretary for Air, they were enlarged to make prints several feet square, and were exhibited in the Smoking Room of the House of Commons for the education of Members of Parliament.

There may be interest in noting that Mr. Sims, who also took several of the photographs that appear in this book, was called up as an R.A.F. reservist at the declaration of war, and ever since has been employed in an Army Co-opera-

tion squadron's dark-room, developing and printing photographs taken by other people. Thus do we use specialists and their knowledge.

The style of specification used is that which my two technical assistants on *The Aeroplane*, Mr. Leonard Bridgman and Mr. Thurstan James, and I, developed in years of experience as the way of giving the greatest amount of information in the least possible space. We adapted the system to *All The World's Aircraft*, the annual work of reference in which the three of us have also collaborated for many years, so we know that it has stood the test of time.

Naturally no more detailed specifications are yet available, because, although the Germans have shot down or captured specimens of all these types, we cannot tell just how much they have learned from them, and therefore cannot give away any more information.

Where a little more information is permissible it has been added as a separate paragraph in brackets.

The standard form of introduction to each specification, as used in *All The World's Aircraft*, is included, because together they make a handy and condensed reference to the narratives of the pedigrees of the machines in Part II of this book.

Again the machines appear in alphabetical order, to avoid awkward questions of precedence.

Appended to them are specifications of the Bristol Mercury and Rolls-Royce Merlin motors, which are the powerplants of all the fighters.

Chapter 23

THE BLENHEIM

Bristol

THE BRISTOL AEROPLANE COMPANY, LIMITED

Head Office, Works, and Aerodrome: Filton, Bristol.
Flying Schools: Filton and Yatesbury, Wilts.
Established: 1910.
Chairman: W. G. Verdon Smith, C.B.E., J.P.
Managing Director: Sir G. Stanley White, Bt.
Assistant Managing Director: H. J. Thomas.
Director: Colonel Sidney E. Smith, C.B.E., J.P.

Formerly known as the British and Colonial Aeroplane Company Ltd., Filton House, Bristol. The first great British aeroplane firm. Founded in 1910 by the late Sir George White, Bart., pioneer of electric tramways. Have very extensive works on the outskirts of Bristol, where they manufacture Bristol aeroplanes and aero-engines.

In 1936 large production orders for the Blenheim High-Performance Day Bomber and the Bombay Bomber-Transport Monoplane were received.

During 1938 the Blenheim was in full production at Filton, in a 'shadow factory' operated by Rootes Securities Ltd., at Speke, and in the works of A. V. Roe & Company Ltd. Production of the Bombay has been entrusted to Short & Harland Ltd., of Belfast. In 1939 the Beaufort was in production

and this type of machine was chosen for production in Australia for the requirements of the Commonwealth and of the R.A.F. in the Middle and Far East.

THE BRISTOL BEAUFORT

The Beaufort is a twin-engined high-performance monoplane capable of fulfilling the functions of a bomber, general reconnaissance, and general purposes landplane. It is of all-metal stressed-skin construction and is fitted with two Bristol Taurus fourteen-cylinder sleeve-valve radial engines. Accommodation is provided for pilot, gunner, navigator, and radio operator.

No details of structure, equipment, armaments, weights, or performances are available for publication.

Dimensions.—Span 57 ft. 10 in. (17·66 m.), length 44 ft. 2 in. (13·46 m.), height 14 ft. 3 in. (4·34 m.).

THE BRISTOL BLENHEIM MARK I

Type.—Twin-engined high-performance day and night bomber.

Wings.—Mid-wing cantilever monoplane. In three sections. Centre-section bolted and riveted to fuselage. Outer sections taper in chord and thickness. Spars built up of two heavy high-tensile steel flanges and a light single-plate Alclad web between them. Web is reinforced with vertical stringers. Ribs are made from Alclad sheet, with flanged edges and lipped lightening holes. Alclad stressed-skin covering is riveted to flanges of spars and ribs. Bristol-Frise mass-balanced ailerons and split trailing-edge flaps. Flaps are of Alclad sheet, with flanged ribs. Ailerons are metal-framed and covered with fabric. Small trimming-tabs in ailerons are adjustable on the ground.

Fuselage.—In three sections. Light alloy monocoque, built

up of formers and open-section stringers, with Alclad skin riveted to the flanges of the formers and stringers.

Tail Unit.—Cantilever monoplane type. Tail-plane and fin are of all-metal construction, similar to the wings. Elevators and rudder are metal-framed and covered with fabric. Fixed tail-plane, with servo strips for fore-and-aft trimming. Servo-tab in rudder. Elevators and rudder are aerodynamically and statically balanced.

Undercarriage.—Retractable type. Each unit is retracted backward by a Bristol hydraulic-jack, which breaks the knee-jointed radius-rods. Auxiliary hand-pump for emergency operation. Full indication and warning devices, comprising visible, audible, and mechanical signals. Intermediate-pressure tyres and pneumatic differentially-controlled wheel-brakes.

Power Plant.—Two Bristol Mercury VIII nine-cylinder radial air-cooled engines in nacelles attached to the extremities of the centre-section. Mountings are of steel-tube, with standard Bristol duralumin mounting ring with split segment at the bottom to facilitate rapid removal of engines without disturbing carburetters. Long-chord cowling rings with leading-edge exhaust-collectors and trailing-edge controllable gills. Three-bladed controllable-pitch airscrews. Two fuel tanks (140 imp. gallons each) in centre-section. Oil tanks (9½ imp. gallons each) in engine nacelles. Hand and electric engine-starters.

Accommodation.—Pilot's seat in nose, on port side, with navigator's seat alongside. A sliding and folding seat ahead of the navigator's seat for use when bomb-aiming. Dual controls can be fitted. Fixed and sliding window panels and transparent sliding roof. In centre-section of fuselage is the internal bomb stowage, with side panels and spring-loaded doors. Aft of the wing is the rear gun-turret mounted midway along the top of the fuselage. Normal crew consists of

pilot, bomb-aimer-navigator and wireless-operator-gunner.

Armament.—One forward-firing gun in the port wing and one gun in a Bristol retractable hydraulically-operated gun-turret. All bombs carried internally in a bomb-cell under the centre-section. A hand-winch for loading is operated from inside the fuselage.

Equipment.—Lighting, radio, photographic and navigation equipment, oxygen apparatus, stowage for parachutes, clothing, etc.

Dimensions.—Span 56 ft. 4 in. (17·16 m.), length 39 ft. 9 in. (12·12 m.), height 9 ft. 10 in. (3 m.), wing area 469 sq. ft. (43·57 sq. m.).

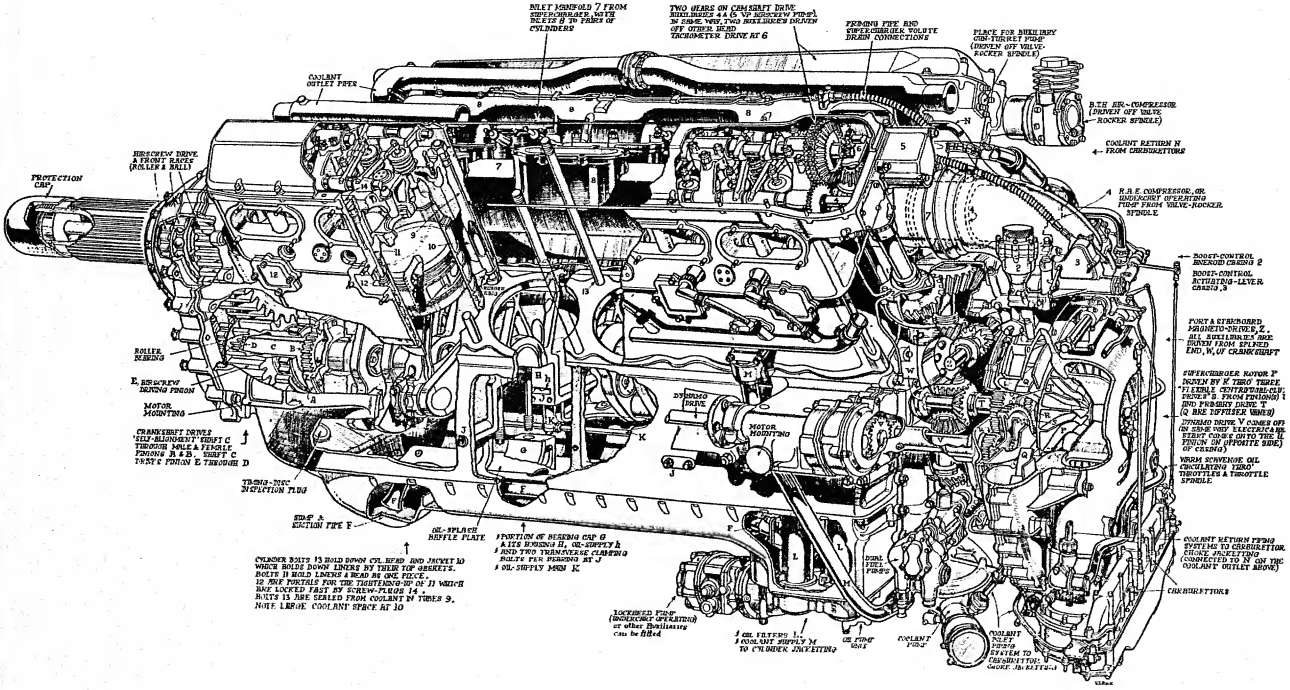
Weights.—Weight empty 8,100 lb. (3,671 kg.); full load, (including 278 gallons (1,264·4 litres) of fuel and 17 gallons (77·3 litres) of oil, 4,400 lb. (1,995 kg.); weight loaded 12,500 lb. (5,460 kg.).

Performance.—Maximum speed at sea-level 240 m.p.h. (386 km.h.); speed at 5,000 ft. (1,525 m.), 254 m.p.h. (409 km.h.); speed at 10,00 ft. (3,050 m.), 269 m.p.h. (433 km.h.); speed at 15,000 ft. (4,575 m.), 275 m.p.h. (458 km.h.); speed at 20,000 ft. (6,100 m.), 277 m.p.h. (445 km.h.). Climb to 5,000 ft. (1,525 m.), 3·7 mins.; climb to 10,000 ft. (3,050 m.), 7·2 mins.; climb to 15,000 ft. (4,575 m.), 11·5 mins.; climb to 20,000 ft. (6,100 m.), 17·5 mins. Service ceiling 27,280 ft. (8,310 m.). Estimated range at 220 m.p.h. (352 km.h.) with full load 1,125 miles (1,810 km.). Take-off run 296 yds. (271 m.). Landing run (with brakes) 364 yds. (333 m.). Landing speed 50 m.p.h. (81 km.h.).

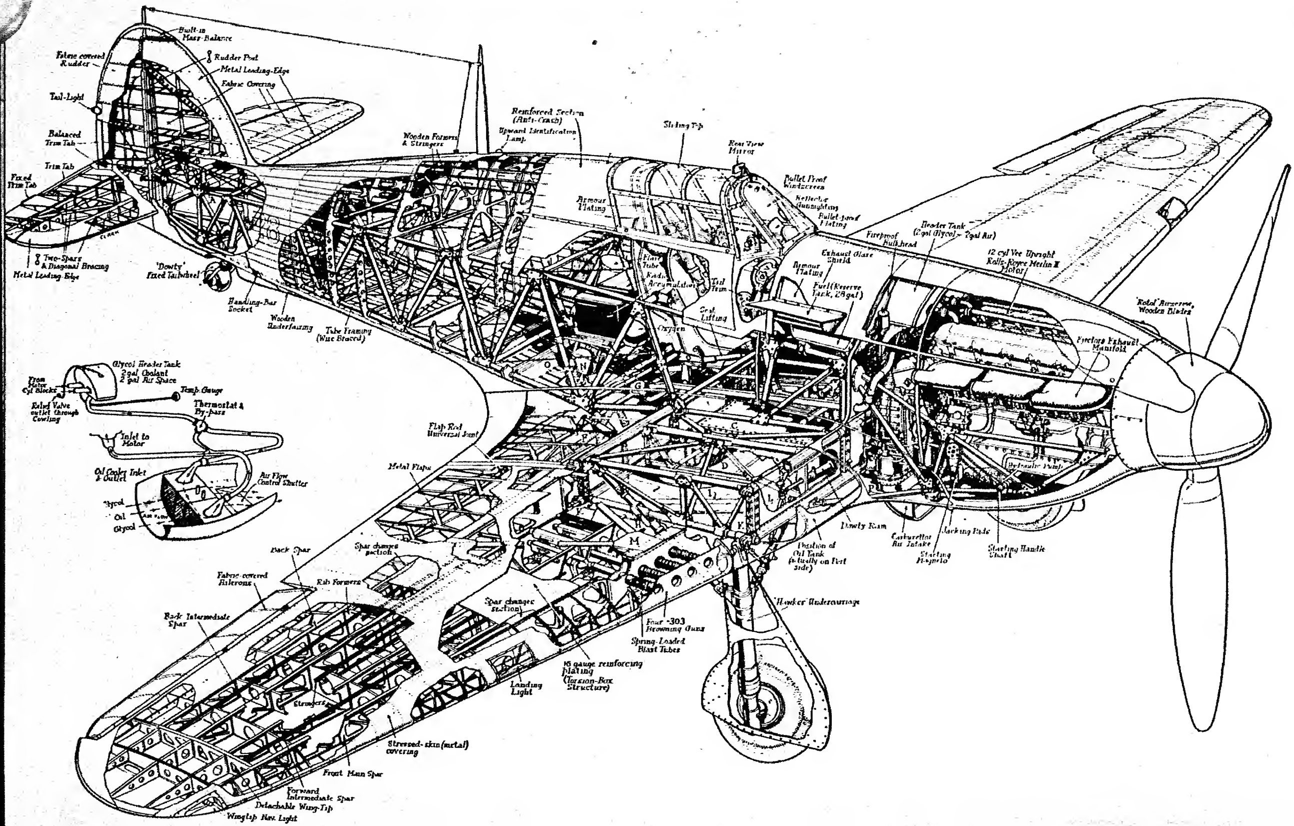
THE BRISTOL BLENHEIM MARK IV

The Mark IV is a development of the previously described model. Externally the most noticeable difference is the long nose, which has been extended by approximately 3 ft. and provides improved navigation and bomb-aiming facilities.

Plate 11. Rolls-Royce Merlin



INLET MANIFOLD 7 FROM SUPERCHARGER, WITH INLETS 8 TO PAIRS OF CYLINDERS
TWO GEARS ON CAMSHAFT DRIVE AUXILIARIES 4 & (5 VP AIRSCREW PUMP). IN SAME WAY, TWO AUXILIARIES DRIVEN OFF OTHER HEAD TACHOMETER DRIVE AT 6
PRIMING PIPE AND SUPERCHARGER VOLUTE DRAIN CONNECTIONS
PLACE FOR AUXILIARY GUN-TURRET PUMP (DRIVEN OFF VALVE-ROCKER SPINDLE)
B.T.H. AIR-COMPRESSOR (DRIVEN OFF VALVE ROCKER SPINDLE)
COOLANT RETURN N FROM CARBURETTORS
COOLANT OUTLET PIPES
AIRSCREW DRIVE & FRONT RACES (ROLLER & BALL)
PROTECTION CAP
R.A.E. COMPRESSOR, OR UNDERCART OPERATING PUMP FROM VALVE-ROCKER SPINDLE
BOOST-CONTROL ANEROID CASING 2
BOOST-CONTROL ACTUATING-LEVER CASING 3
PORT & STARBOARD MAGNETO-DRIVES, Z. ALL AUXILIARIES ARE DRIVEN FROM SPLINED END, W, OF CRANKSHAFT
SUPERCHARGER ROTOR P DRIVEN BY R THRO' THREE "FLEXIBLE CENTRIFUGAL-CLU DRIVES" S. FROM PINION(S) AND PRIMARY DRIVE T (Q ARE DIFFUSER VANES)
DYNAMO DRIVE V COMES OFF (IN SAME WAY ELECTRICAL START COMES ON TO THE PINION ON OPPOSITE SIDE) OF CASING)
WARM SCAVENGE OIL CIRCULATING THRO' THROTTLES & THROTTLE SPINDLE
ROLLER BEARING
E, AIRSCREW DRIVING PINION
MOTOR MOUNTING
CRANKSHAFT DRIVES 'SELF-ALIGNMENT' SHAFT C THROUGH MALE & FEMALE PINIONS A & B. SHAFT C TURNS PINION E THROUGH D
DYNAMO DRIVE
MOTOR MOUNTING
TIMING-DISC INSPECTION PLUG
SUMP & SUCTION PIPE F
OIL-SPLASH BAFFLE PLATE
PORTION OF BEARING CAP G & ITS HOUSING H, OIL-SUPPLY h AND TWO TRANSVERSE CLAMPING BOLTS PER BEARING AT J
OIL-SUPPLY MAIN K
CYLINDER BOLTS 13 HOLD DOWN CYL. HEAD AND JACKET 10 WHICH HOLDS DOWN LINERS BY THEIR TOP GASKETS. BOLTS 11 HOLD LINERS & HEAD AS ONE PIECE. 12 ARE PORTALS FOR THE TIGHTENING-UP OF 11 WHICH ARE LOCKED FAST BY SCREW-PLUGS 14. BOLTS 13 ARE SEALED FROM COOLANT IN TUBES 9. NOTE LARGE COOLANT SPACE AT 10
LOCKHEED PUMP (UNDERCART OPERATING) or other Auxiliaries can be fitted
OIL FILTERS L. COOLANT SUPPLY M TO CYLINDER JACKETTING
OIL PUMP UNIT
DUAL FUEL PUMPS
COOLANT PUMP
COOLANT INLET PIPING SYSTEM TO CARBURETTOR CHOKE JACKETTING
COOLANT RETURN PIPING SYSTEMS TO CARBURETTOR CHOKE JACKETTING (CONNECTED TO N ON THE COOLANT OUTLET ABOVE)
CARBURETTORS


Built-in Mass-Balance
Fabric covered Rudder
Rudder Post
Metal Leading-Edge
Fabric Covering
Tail-Light
Balanced Trim Tab
Trim Tab
Fixed Trim Tab
Two-Spars & Diagonal Bracing
Metal Leading-Edge
'Dowty' Fixed Tailwheel
Handling-Bar Socket
Wooden Underfairing
Tube Framing (Wire Braced)
Wooden Formers & Stringers
Reinforced Section (Anti-Crash)
Upward Identification Lamp
Sliding Top
Rear View Mirror
Armour Plating
Bullet Proof Windscreen
Reflector Gunsighting
Bullet-proof Plating
Fireproof Bulkhead
Header Tank (2gal Glycol - 2gal Air)
12 cyl Vee Upright Rolls-Royce Merlin II Motor
Exhaust Glare Shield
Armour Plating
Fuel (Reserve Tank, 28 gal)
Tail Trim
Seat Lifting
Oxygen
'Rotol' Airscrew, Wooden Blades
Ejectors Exhaust Manifold
Glycol Header Tank 2gal Coolant 2 gal Air Space
From Motor Cyl Blocks
Temp Gauge
Relief Valve outlet through Cowling
Thermostat & By-pass
Inlet to Motor
Oil Cooler Inlet & Outlet
Air Flow Control Shutter
Glycol
Oil
Glycol
Flap Rod Universal Joint
Metal Flaps
Hydraulic Pump
Dowty Ram
Carburettor Air Intake
Jacking Pads
Starting Magneto
Starting Handle Shaft
Position of Oil Tank (actually on Port side)
Back Spar
Spar changes section
Fabric-covered Ailerons
Rib Formers
Back Intermediate Spar
Spar changes section
'Hawker' Undercarriage
Four ·303 Browning Guns
Spring-Loaded Blast Tubes
16 gauge reinforcing plating (Torsion-Box Structure)
Landing Light
Stringers
Stressed-skin (metal) covering
Front Main Spar
Forward Intermediate Spar
Detachable Wing-Tip
Wingtip Nav. Light

The Mark IV is also provided with additional tanks in the wings to give an increased range of 1,900 miles (3,040 kilometres).

The maximum speed of this model at operating height and with full load is now 295 m.p.h. (472 kms.). The effective near load remains the same as in the original Blenheim. The dimensions remain the same, with the exception of the length, which is 42 ft. 9 in. (13 metres).

[The Blenheim Fighter, and the Beaufighter, which to-day may just be mentioned, although people in aviation have been talking about it freely for months, are at the moment our leading long-range and night-flying fighters. As related in Part II, a battery of guns have been fitted below the fuselage with good effect.—C. G. G.]

Plate 12. Hurricane

Chapter 24

THE DEFIANT

▼

BOULTON-PAUL AIRCRAFT LTD.

Head Office, Works, and Aerodrome: The Airport, Wolverhampton.

Incorporated: June 1934.

Chairman: The Rt. Hon. Lord Gorell, C.B.E., M.C.

Directors: The Rt. Hon. The Viscount Sandon, D.L., J.P., J. D. North, F.R.Ae.S., M.I.Ae.E., and H. Strickland (Managing Director).

The Aircraft Department of Boulton & Paul Ltd., a big firm of building and general engineers, was formed in 1916.

In 1934 Boulton-Paul Aircraft Ltd. was formed to take over the Aircraft Department of Boulton & Paul Ltd., together with one-third of the issued capital of A.T.S. Ltd., which firm was incorporated in 1931 to hold a large number of patents relating to metal construction, pooled by the following aircraft companies: Boulton & Paul Ltd., Gloster Aircraft Company Ltd., Sir W. G. Armstrong Whitworth Aircraft Ltd., and the Steel Wing Company Ltd.

During 1936 Boulton & Paul Ltd. moved its works from Norwich to its new factory at Wolverhampton.

The Company's works, which it has been necessary to extend very considerably since they were built in 1936, are fully occupied on the quantity production of the Boulton-Paul Defiant, described hereunder, and of the Blackburn Roc, a

two-seat fighter version of the Skua fitted with a Boulton Paul gun-turret.

The Company has also designed and is producing large quantities of mechanically-operated gun-turrets of various types, and is developing new experimental aircraft, details of which are not yet available for publication.

THE BOULTON PAUL DEFIANT

The Defiant is a two-seat fighter monoplane of stressed-skin construction and is believed to be the fastest aeroplane of its class in service.

Type.—Two-seat fighter monoplane.

Wings.—Low-wing cantilever monoplane. All-metal construction. Wings taper in chord and thickness from centre to rounded tips. 'Frise' ailerons. Split-flaps fitted to inner portion of span.

Fuselage.—All-metal monocoque of approximately elliptical section. All external riveting of flush type.

Tail Unit.—Cantilever monoplane type. Fixed surfaces metal-covered. Movable surfaces fabric-covered, horn-balanced, and fitted with trimming-tabs.

Undercarriage.—Retractable type. Wheels swing upwards and inwards into centre wing, apertures in wing then being closed by fairing plates attached to undercarriage structure.

Power Plant.—One Rolls-Royce Merlin twelve-cylinder Vee type liquid cooled-engine. Three-bladed de Havilland controllable-pitch airscrew.

Accommodation.—Enclosed cockpit for pilot over forward part of wing. Power-operated multi-gun turret for gunner mounted immediately behind pilot's cockpit.

Dimensions.—Span 39 ft. 6 in. (12 m.), length 30 ft. (9·14 m.), height (tail down) 12 ft. (3·65 m.).

Weights and Performance.—No data available.

[At the time of writing (March 1941) the functions of the

Defiant are being altered. Since the Germans abandoned the use of the Junkers Stuka dive-bomber against this country there has been no obvious use for the Defiant, as it is admittedly too slow to catch the Messerschmitt and Heinkel fighters. Therefore a new use for it in a modified form has been found as a night-fighter.—C. G. G.]

Chapter 25

THE GLADIATOR

▼

Gloster

THE GLOSTER AIRCRAFT COMPANY LTD.

Head Office, Works, and Aerodrome: Hucclecote, Glos.

London Office: 3 St. James's Square, S.W.1.

Chairman: Sir F. S. Spriggs, F.S.A.

Managing Director: H. K. Jones.

Directors: H. Burroughes, T. O. M. Sopwith, F. I. Bennett.

Chief Designer: W. G. Carter, M.B.E., F.R.Ae.S.

Director and General Manager: F. McKenna, M.I.Ae.S.E., F.R.S.A.

Secretary: E. Shambrook.

The Gloster Aircraft Company Ltd. was formed in 1917, and during the war built a large number of aircraft of external design for the fighting services. After the war, the firm formed its own Design Department and began the manufacture of Gloster aeroplanes, several types being supplied to the R.A.F. and certain foreign governments.

In 1921, the firm embarked on a programme of high-speed development beginning with the production in 1921 of the Gloster Bamel. This was the first of a series of Gloster racing aircraft, and the winner of three consecutive Aerial Derby Races in 1921, 1922, and 1923. This was followed by a series of racing machines specially designed and built for the Schneider Trophy Contest in 1923 (Gloster II), 1925 (Glos-

ter III), 1927 (Gloster IV), and 1929 (Gloster VI). The last-mentioned machine established a World's Speed Record of 336·3 m.p.h., at Calshot, on 10th September 1929.

In the period 1922 to 1927 the firm's products were supplied in quantity to the Royal Air Force, the best-remembered being the Nightjar, supplied to the Fleet Air Arm, and the Grebe and Gamecock, which were standard R.A.F. fighter equipment for many years.

In 1927 the Steel Wing Company, the pioneer company in the application of steel strip to aircraft construction, was absorbed. The development of this type of construction was carried on by the Gloster Company.

Early in 1934, the Company was taken over by Hawker Aircraft Ltd. About two years later the Hawker-Siddeley group was formed and the Gloster Aircraft Company Ltd. is now a subsidiary of this group.

During the past few years considerable expansion has taken place at the Hucclecote Works and this has become one of the largest airframe-producing plants in the United Kingdom.

The two Gloster single-seat fighter types illustrated and described below, namely, the Gauntlet and the Gladiator, have been produced in quantity for the R.A.F. The Gladiator has also been supplied to the Governments of Belgium, Sweden, Portugal, 'Iraq, Lithuania, Latvia, and Éire. Several new prototypes are also in course of development, one of which, the F.5/35, is briefly described hereafter. The Company is also engaged in extensive sub-contract work for the Air Ministry.

In production during 1938–9 were the Gladiator, Sea Gladiator, and the Hawker Henley.

The Gladiator has been supplied in large numbers to the R.A.F. and the Air Forces of Belgium, Sweden, Norway, Portugal, 'Iraq, Lithuania, Latvia, Éire, and several others.

The Sea Gladiator is a variant of the Gladiator, developed for the Fleet Air Arm. It is specially equipped with deck-arrester gear, catapult points, marine salvage gear, collapsible dinghy, etc.

THE GLOSTER GLADIATOR

Type.—Single-seat multi-gun fighter.

Wings.—Single-bay equal-span biplane. Centre-section carried above fuselage by splayed-out struts, one pair of parallel struts on either side of fuselage. Metal wing structure consists of two 'dumb-bell' section high-tensile steel spars and duralumin former ribs, the whole covered with fabric. Fabric attached to main drag ribs by Gloster patented wired-on method. 'Frise' ailerons on upper and lower wings.

Fuselage.—Rectangular metal structure, faired to an oval section and covered forward with metal panels and aft with fabric over a light metal structure in the form of hoops and stringers. Fuselage is in three sections. The forward section forms the engine-mounting. The centre-portion is built up of square tubes, assembled with wrapped joints and tie-rod bracing. The rear portion is built up of round tubes, squared at the strut points, forming a Warren girder side frame and braced in plan by tie-rods.

Tail Unit.—Normal monoplane type. Steel-tube and duralumin strip framework, covered with fabric. Adjustable tail-plane.

Undercarriage.—Single-strut cantilever type. Consists of two Dowty cantilever legs, carrying at their lower ends two Dowty internally-sprung wheels. Dunlop brakes operated from lever on control column with independent wheel action worked by rudder-bar. Dowty tail-wheel unit.

Power Plant.—One Bristol Mercury IX nine-cylinder radial air-cooled geared and supercharged engine. Combined Town

end ring and leading-edge exhaust-collector ring. Fuel tanks in fuselage.

Accommodation.—Pilot's enclosed cockpit aft of trailing-edge of upper wing.

Armament.—Four machine-guns, two mounted in troughs in the sides of the fuselage and easily accessible to the pilot, and two mounted below the lower wing, one on either side of the fuselage and firing outside the airscrew radius. Full day and night-flying equipment, oxygen, transmitting and receiving wireless.

Dimensions.—Span 32 ft. 3 in. (9·85 m.), length 27 ft. 5 in. (8·36 m.), height 10 ft. 4 in. (3·15 m.), wing area 323 sq. ft. (30 sq. m.).

Weight Loaded.—4,750 lb. (2,150 kg.).

Performance.—Maximum speed at 15,500 ft. (4,420 m.), 250 m.p.h. (402 km.h.); stalling speed, 63 m.p.h. (101·5 km.h.); climb to 5,000 ft. (1,525 m.), 1·9 mins.; climb to 10,000 ft. (3,050 m.), 3·8 mins.; climb to 15,000 ft. (4,575 m.), 5·8 mins.; climb to 20,000 ft. (6,100 m.), 9 mins. Service ceiling 32,800 ft. (10,000 m.).

Chapter 26

THE HURRICANE

Hawker

HAWKER AIRCRAFT LTD.

Head Office and Works: Kingston-on-Thames, Surrey.

London Office: 3 St. James's Square, S.W.1.

Established: 1933.

Chairman: Sir F. S. Spriggs.

Managing Director: H. K. Jones.

Director and Chief Engineer: F. I. Bennett.

Director and Chief Test Pilot: Flight-Lieutenant P. W. S. Bulman, M.C., A.F.C., F.R.Ae.S.

Director and Chief Designer: S. Camm, F.R.Ae.S.

Director and Secretary: H. Chandler.

Director: T. O. M. Sopwith.

Hawker Aircraft Ltd. was incorporated in 1933 as successor to the H. G. Hawker Engineering Company Ltd., which was formed in 1920 as the outcome of the voluntary liquidation of the famous Sopwith concern.

Early in 1934 Hawker Aircraft Ltd. took over the Gloster Aircraft Company Ltd., which is now a subsidiary of the Hawker Company.

The Company specializes in the design and construction of military aircraft.

The latest Hawker types of which it is permissible to pub-

lish details are the Hurricane single-seat fighter and the Henley two-seat medium bomber and target-towing monoplane, the latter being in production in the works of the Gloster Aircraft Company Ltd.

Although the resources of the Company are primarily at the disposal of the British Air Ministry, an extensive export trade has been established and among the foreign governments that have placed orders for Hawker aircraft are Belgium, Denmark, Egypt, Estonia, Greece, 'Iraq, Iran, Japan, Latvia, Norway, Portugal, Sweden, Switzerland, and Yugoslavia. In addition to the aircraft actually supplied, the licence to build Hawker designs has been acquired by six of these countries.

THE HAWKER HURRICANE

Type.—Single-seat fighter monoplane.

Wings.—Low-wing cantilever monoplane. Centre-section of parallel chord and thickness and two tapering outer sections. Two-spar metal structure with metal leading-edge and fabric covering. Spars have polygonal booms of heat-treated steel strip and webs of aluminium-alloy, and are interconnected by a system of diagonal bracing, the diagonals being of similar construction to the spars. Former ribs of rolled channel section are closely spaced and fabric is secured to them by further channels screwed into the troughs of the rib channels, strips of fabric being doped over each rib to give a smooth outer finish. All-metal split flaps between ailerons and beneath the fuselage.

Fuselage.—Rectangular rigidly-braced structure of steel and aluminium-alloy tubing assembled by flat-plate fittings and hollow rivets, faired to an oval section and covered forward with detachable metal panels and aft with fabric over light wooden formers.

Tail Unit.—Cantilever monoplane type. Fin integral with

the fuselage. Fixed tail-plane with adjustable trimming-tabs in each aerodynamically balanced elevator. Aerodynamically and statically-balanced rudder. Metal fabric-covered structure same as for wings.

Undercarriage.—Retractable type. Two Dowty shock-absorber struts hinged at the extremities of the centre-section front spar and retracted inwards and slightly backwards by Dowty hydraulic rams to bring wheels between spars when raised. The slight backward motion is imparted by a hinged back strut which slides on a guide at right angles to the span of the wing. Dunlop wheels and hydraulic brakes. Dowty retractable tail-wheel unit.

Power Plant.—One Rolls-Royce Merlin II twelve-cylinder Vee liquid-cooled engine rated at 990 h.p. at 12,000 ft. (3,660 m.) and giving a maximum output of 1,050 h.p. at 16,000 ft. (4,880 m.). Fixed-pitch wooden airscrew. Main fuel tanks (two) in centre-section between spars with gravity tank in fuselage. Ducted radiator under fuselage below cockpit. Oil tank in leading-edge of centre-section on port side. Oil-cooler incorporated in main radiator.

Accommodation.—Enclosed pilot's cockpit over wing. Sliding canopy with quick-release for emergency exit. Further emergency escape panel in side of fuselage between upper longeron and canopy. Seat adjustable for height, rudder-bar for length of leg.

Armament and Equipment.—Eight machine-guns in wings, four on each side of fuselage, firing outside disk swept by airscrew. Night-flying equipment with landing-lights in leading-edge of outer wing sections, navigation lights, oxygen equipment, radio, flare tubes in fuselage behind pilot, etc.

Dimensions.—Span 40 ft. (12·2 m.), length 31 ft. 5 in. (9·58 m.), height (on wheels) 13 ft. 3 in. (4·04 m.); wing area 257·5 sq. ft. (23·92 sq. m.); track 7 ft. 10 in. (2·38 m.); airscrew diameter 11 ft. 2½ in. (3·43 m.).

Weights and Loadings.—Weight empty 4,670 lb. (2,120 kg.); weight loaded 6,000 lb. (2,724 kg.); wing loading 23·3 lb./sq. ft. (113·8 kg./sq. m.); power loading (take-off) 6·7 lb./h.p. (3·04 kg./h.p.).

Performance.—Speed at sea-level 260 m.p.h. (416 km.h.). Maximum speed 335 m.p.h. (536 km.h.) at 17,500 ft. (5,185 m.). Landing speed 62 m.p.h. (99·2 km.h.). Initial rate of climb 2,400 ft./min. (762 m./min.); rate of climb at 10,000 ft. (3,050 m.) 2,500 ft./min. (45·75 m./min.); climb to 10,000 ft. (3,050 m.) 4·1 mins.; climb to 20,000 ft. (6,100 m.) 9 mins.; service ceiling 34,000 ft. (10,370 m.). Range 550 miles. (880 km.).

[Since these performance-figures were published much work has been done in smoothing off the outside of the machine to increase the speed. New wings with stressed metal skins instead of fabric have been fitted, and are believed to have added some miles per hour. The latest Merlin motors of higher h.p. have also increased the speed so that performance has been stepped up considerably.

Experiments have been made with air-cannons and have been very satisfactory.—C. G. G.]

Chapter 27

THE SPITFIRE

▼

Supermarine

VICKERS-ARMSTRONGS LTD.

Supermarine Works: Southampton.

Aerodrome: Eastleigh, Southampton.

London Office: Vickers House, Broadway, Westminster, S.W.1.

Directors: Commander Sir Charles Craven (Chairman), J. Callender, A. Dunbar (Director-in-Charge of Aircraft Section), Major H. R. Kilner, M.C. (General Manager, Aircraft Section), Commander E. R. Micklem, R.N., A. B. Winder, F. C. Yapp, A. J. Palmer, and J. Reid Young, C.A., F.C.I.S. (Secretary).

Assistant General Manager, Aircraft Section: B. W. A. Dickson.

General Manager, Supermarine Works: H. B. Pratt.

In October 1938 the Supermarine Aviation Works (Vickers) Ltd. was, with its parent company Vickers (Aviation) Ltd., taken over by Vickers-Armstrongs Ltd.

The original Supermarine Company was formed in 1912 and its efforts were chiefly devoted to the production of sea-going aircraft. The firm also specialized in the design and production of high-speed seaplanes and it earned the enviable reputation of winning the Schneider Trophy Contest four times.

The 1922 Contest, at Naples, was won by the Supermarine Sea Lion Mark II flying-boat at an average speed of 146 m.p.h. In the 1927 Contest two Supermarine S.5 seaplanes came first and second at average speeds of 281·65 and 273·07 m.p.h. respectively.

The 1929 Contest was won by the Supermarine S.6 at an average speed of 328·63 m.p.h. The S.6 later put the World's Speed Record up to 357·7 m.p.h. and the same type also held the Speed Records over 50 and 100 kilometres.

In the 1931 Contest the Supermarine S.6B won the Schneider Trophy outright for Great Britain at a speed of 340·08 m.p.h. and raised the World's Record for speed over 100 kilometres to 342·7 m.p.h. On the same day another machine of the same type raised the World's Speed Record to 379·05 m.p.h.

On the 29th September 1931 the machine that won the Schneider Trophy, but fitted with a special 'sprint' engine, raised the World's Speed Record to 407·5 m.p.h.

In November 1928 Vickers (Aviation) Ltd. took over the control of the Supermarine Aviation Works Ltd.

Since the year 1938 the Supermarine works have been mainly engaged in the large-scale production of the Spitfire single-seat fighter monoplane. The Spitfire is the first landplane of Supermarine design to be ordered in quantity for the Royal Air Force.

THE SUPERMARINE SPITFIRE

Type.—Single-seat multi-gun day and night fighter.

Wings.—Low-wing cantilever monoplane. Wings are elliptical in plan and taper in thickness. Structure is chiefly of light alloy. Single spar with tubular flanges and a plate web. Forward of spar wing is covered with heavy-gauge light alloy sheet which forms with the spar web a stiff and strong torsion box. Aft of spar the thinner gauge covering is supported

by light alloy girder ribs. Detachable wing-tips. Split flaps between ailerons and fuselage.

Fuselage.—All-metal monocoque. Structure consists of transverse frames, four main longerons, intercostal longitudinals and flush-riveted Alclad skin. Foremost frame forms a fireproof bulkhead and has built into it the centre portion of the main wing spar. Tail portion of fuselage incorporating fin and tail-plane is detachable.

Tail Unit.—Cantilever monoplane type. Fin integral with detachable tail-end of fuselage. Tail-plane all-metal with smooth skin covering. Elevator and rudder have light alloy frames and fabric covering. Trimming-tabs in elevator and rudder.

Undercarriage.—Retractable type. Consists of two Vickers cantilever oleo-pneumatic shock-absorber legs which are raised outwardly into underside of wings. Hydraulic retraction with emergency device for lowering wheels in case of failure of normal system. Full castoring tail-wheel.

Power Plant.—One Rolls Royce Merlin II twelve-cylinder Vee liquid-cooled engine rated at 990 h.p. at 12,250 ft. (3,740 m.) and giving a maximum output of 1,030 h.p. at 16,250 ft. (4,956 m.). Steel-tube mounting. Three-bladed D.H. controllable pitch airscrew. Radiator in duct below starboard wing with hinged flap for temperature control. Oil tank (5½ imp. gallons capacity) below engine with its surface forming part of body contour. Two fuel tanks (85 imp. gallons capacity) in fuselage with direct feed to engine pumps. Electric starter and hand-turning gear.

Accommodation.—Enclosed cockpit over wing. Sliding canopy and hinged panel in side of fuselage for entry and exit. Adjustable seat and rudder pedals.

Armament and Equipment.—Eight Browning guns mounted in wings, four on each side of fuselage. Access doors in top and bottom surfaces of wings for maintenance and inspec-

tion. Camera-gun can be fitted for training. Provision for radio installation. Full electrical, night flying and blind flying equipment and instruments.

Dimensions.—Span 36 ft. 10 in. (11·25 m.), length 29 ft. 11 in. (9·15 m.), height (airscrew vertical) 11 ft. 5 in. (3,479 m.); wing area 242 sq. ft. (22·5 sq. m.).

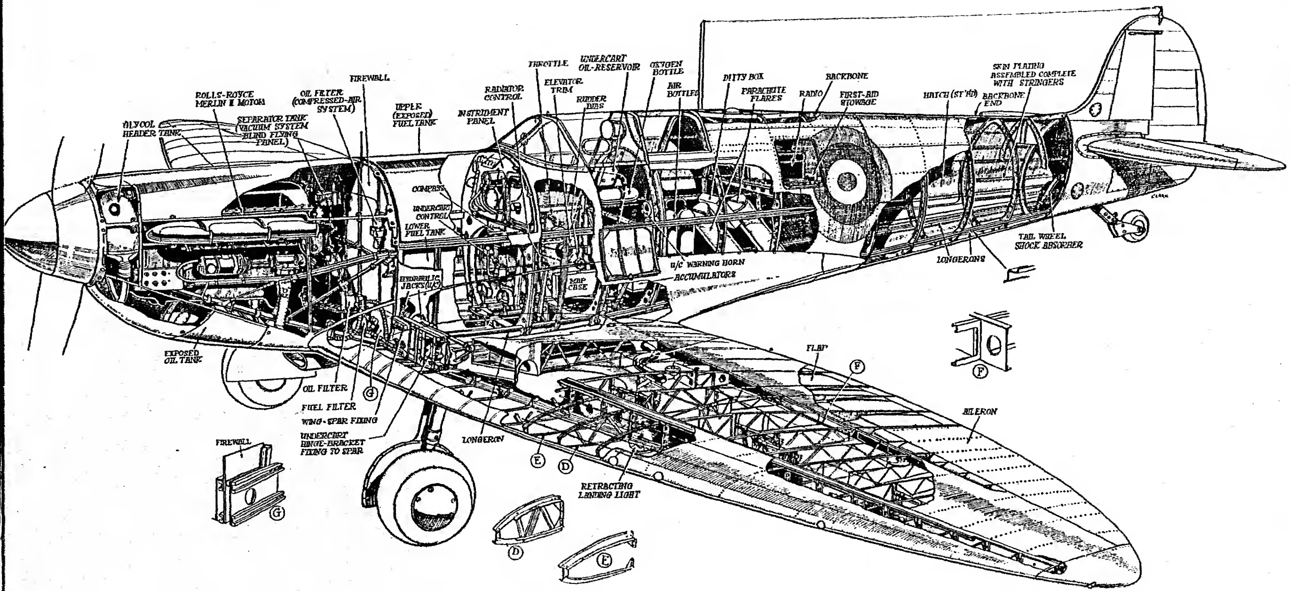
Weights.—No figures available.

Performance.—Maximum speed at 18,400 ft. (5,612 m.) 367 m.p.h. (587 km.h.). Climb to 11,000 ft. (3,355 m.) 4·8 mins.

[Since this specification was published, refinements in the contours of the airframe, and boosting of the Merlin motor by various means (such presumably as raising the compression and the use of higher octane fuel) has raised the speed considerably. Naturally no official figures have been made public.

Experiments with air-cannons fitted in Spitfires have given good results.—C. G. G.]

Plate 13. Spitfire


GLYCOL HEADER TANK
ROLLS-ROYCE MERLIN II MOTOR
SEPARATOR TANK (VACUUM SYSTEM BLIND FLYING PANEL)
OIL FILTER (COMPRESSED-AIR SYSTEM)
FIREWALL
UPPER (EXPOSED) FUEL TANK
INSTRUMENT PANEL
RADIATOR CONTROL
THROTTLE
ELEVATOR TRIM
RUDDER BIAS
UNDERCART OIL-RESERVOIR
OXYGEN BOTTLE
AIR BOTTLES
DITTY BOX
PARACHUTE FLARES
RADIO
BACKBONE
FIRST-AID STOWAGE
HATCH (ST'BD)
BACKBONE END
SKIN PLATING ASSEMBLED COMPLETE WITH STRINGERS
TAIL WHEEL SHOCK ABSORBER
LONGERONS
COMPASS
UNDERCART CONTROL
LOWER FUEL TANK
HYDRAULIC JACKS (U/C)
MAP CASE
U/C WARNING HORN
ACCUMULATORS
EXPOSED OIL TANK
OIL FILTER
FUEL FILTER
WING-SPAR FIXING
UNDERCART HINGE-BRACKET FIXING TO SPAR
LONGERON
FLAP
AILERON
RETRACTING LANDING LIGHT
FIREWALL
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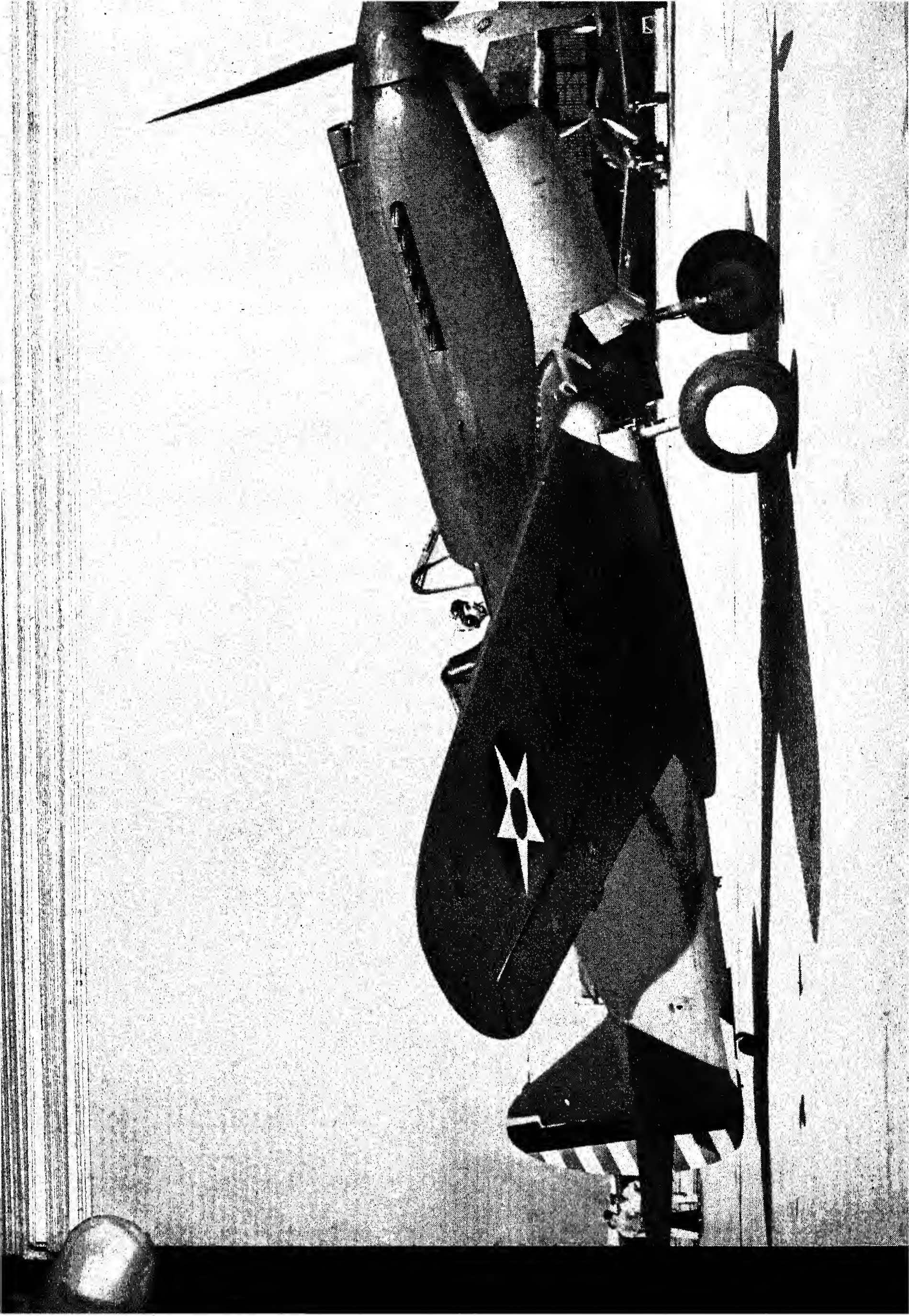

Chapter 28

BRISTOL MERCURY

Bristol

THE BRISTOL AEROPLANE COMPANY LTD.

Head Office and Works: Filton, Bristol.
Telegraphic Address: Aviation Bristol.
Chairman: W. G. Verdon Smith, C.B.E., J.P.
Managing Director: Sir G. Stanley White, Bart.
Assistant Managing Director: H. J. Thomas.
Director: Colonel Sidney E. Smith, C.B.E., J.P.
Chief Designer (aero-engines): Roy Fedden.

Since the Bristol Aeroplane Company took over the Cosmos Jupiter engine, and its designer Mr. Roy Fedden, and began the manufacture of air-cooled aero-engines, in 1920, the position they rapidly assumed throughout the world as producers of engines has been steadily improved.

Bristol engines are used by a large number of air forces and commercial air-lines all over the world. They are extensively used by Imperial Airways Ltd. All the 'Empire' flying-boats, which operated over 130,000 miles per week, had Bristol engines. Bristol engines have been standardized in many of the new high-performance machines now in production for the Royal Air Force and the Fleet Air Arm. They were selected from among all other makes for manufacture by the shadow industry.

Bristol Pegasus engines were also used in the Vickers Wellesley long-range bombers which set up the present

Plate 14. Curtiss P40 Tomahawk

World's Long Distance Record of 7,162 miles on the 5th–7th November 1938, by flying from Egypt (Ismailia) to Australia (Darwin) in formation.

THE BRISTOL PEGASUS AND MERCURY ENGINES

The latest types of this famous series of Bristol nine-cylinder radial air-cooled engines are given in the table below. The Mercury types have a shorter stroke than the Pegasus types, and are therefore more compact and of less overall diameter. (Where more than one type number is shown under one heading, the only difference between the engines concerned is in the airscrew reduction gear ratio.)

The following general description is common to all types unless otherwise stated.

Cylinders.—Open-ended barrel machined from an alloy steel forging. Bores surface-hardened. Forged aluminium-alloy heads shrunk and locked in position.

Pistons.—Full-skirted type. Machined inside and outside from aluminium-alloy forgings. One single, one double scraper ring and two gas rings. Robust fully-floating, case-hardened gudgeon pins.

Connecting Rods.—I-section, machined from alloy steel stampings. The one-piece big-end of the master-rod bears directly on fully-floating big-end bearing bush.

Crankshaft.—Two-piece, machined from alloy steel stampings. Front half, which incorporates large-diameter crankpin, is surface-hardened all over. Separate tail-shaft for auxiliary drives. Carried on two main roller-bearings, with a deep groove journal-bearing at the reduction end and steadying bearing in rear.

Crankcase.—Machined from aluminium-alloy forgings split on centre-line of cylinders and held with nine through-bolts.

Valve Gear.—Two inlet and two sodium-cooled stellited

exhaust valves and stellited seats per cylinder. Clearances between rockers and valves automatically compensated for expansion. A two-row cam runs concentric with the crankshaft in front of the crank at one-eighth engine speed in an anti-crank direction. It operates the tappets through rollers on floating bronze bushes, and thence by push-rods, enclosed in oval tubes.

Carburation.—Claudel-Hobson carburetter, with delayed action acceleration pump, variable datum automatic boost and mixture control and slow-running cut-out. Controllable hot and cold air-intakes. Hot oil circulated round chokes.

Supercharger.—High-speed centrifugal type. Driven off crankshaft through spring-drive and automatic centrifugal clutches. Aluminium-alloy supercharger casing with integral diffuser vanes. Aluminium-alloy volute casing. Whole unit mounted behind rear wall of crankcase, on nine crankcase bolts.

Ignition.—Dual ignition by two B.T.H. or Rotax magnetos transversely mounted on rear cover and driven by bevel gearing from crankshaft. Variable-timing device interconnected with carburetter to give best setting for various throttle openings. Completely screened ignition system, with K.L.G. sparking-plugs.

Lubrication.—Dry sump, with pressure feed. Duplex gear pump incorporates pressure and scavenge units in one assembly. Separate feed and scavenge filters. Special device provides high initial oil pressure for rapid opening to full power.

Airscrew Drive.—For reduction ratios see table. Self-centralizing bevel-epicyclic gear. All bearings pressure-lubricated. Airscrew shafts suitable for either fixed or controllable pitch hubs. Oil-transfer housing and internal oil-seal provided for Hamilton pitch-control mechanism.

Accessory Drives.—Provision for single or dual fuel pump,

high and low pressure air-compressors, shaft-driven electric generator, hydraulic pump, vacuum pump; also for constant-speed airscrew governor and pump unit.

Starter System.—Combined electric and hand-turning gear.

Exhaust System and Cowling.—Complete standardized units, combining ring-type exhaust manifold and long or short-chord cowlings, are available. Long-chord cowlings embody controllable gills.

Dimensions.
Weights. } See table opposite.
Performance.

	Mercury VIII and IX Fully Supercharged	*Mercury XI and XII Medium Supercharged*
Number of cylinders	9	9
Bore	$5\frac{3}{4}$ in. (146 mm.)	$5\frac{3}{4}$ in. (146 mm.)
Stroke	$6\frac{1}{2}$ in. (165 mm.)	$6\frac{1}{2}$ in. (165 mm.)
Capacity	1,520 cu. in. (24·9 litres)	1,520 cu. in. (24·9 litres)
Rotation	L.H. Tractor	L.H. Tractor
Gear ratio	VIII 0·572 : 1 IX 0·500 : 1	XI 0·572 : 1 XII 0·500 : 1
Diameter	51·5 in. (1·307 m.)	51·5 in. (1·307 m.)
Weight (bare dry)	VIII 1,010 lb. (458 kg.) IX 1,005 lb. (456 kg.)	XI 1,010 lb. (458 kg.) XII 1,005 lb. (456 kg.)
Take-off power	725 h.p. at 2,650 r.p.m.	830 h.p. at 2,650 r.p.m.
International rated power	795/825 h.p. at 13,000 ft. (3,960 m.) at 2,650 r.p.m.	790/820 h.p. at 3,500 ft. (1,070 m.) at 2,400 r.p.m.
Maximum power (all-out level flight for 5 mins.)	840 h.p. at 14,000 ft. (4,265 m.) at 2,750 r.p.m.	890 h.p. at 6,000 ft. (1,830 m.) at 2,750 r.p.m.

Chapter 29

ROLLS-ROYCE MERLIN

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Rolls-Royce

ROLLS-ROYCE LTD.

Head Office and Works: Nightingale Road, Derby.

London Office: 14–15 Conduit Street, W.1.

Telegraphic Address: Rolhead, Piccy-London.

Established: 15 March 1906.

Managing Director: A. F. Sidgreaves.

Rolls-Royce Ltd. are at present producing the Peregrine and Merlin liquid-cooled twelve-cylinder Vee engines. The Kestrel, of which over 4,000 have been supplied to users all over the world is now specified for use as the Kestrel XXX in certain trainer aircraft for the Royal Air Force. The various types of Kestrel have been described at length in previous editions. Their characteristics and performances are given in the table.

The Merlin is used in the latest single-seat fighters supplied to the R.A.F. as well as in high-performance bombers.

Arrangements had been made to build the Merlin under licence in France. They are now to be built in the U.S.A.

THE ROLLS-ROYCE MERLIN

The Merlin engine, a geared and supercharged twelve-cylinder Vee, has a total cylinder displacement 27 per cent greater than that of the Kestrel series.

In order to improve the power at take-off and at low heights, and fuel economy when cruising, the Merlin X has been developed with a two-speed supercharger drive and has completed its type test.

The main constructional features of the Merlin closely follow the well-tried principles of previous Rolls-Royce practice, but the engine incorporates the progressive innovations that are expected in a modern high-output aero-engine.

It is designed to operate under high temperature liquid-cooled conditions, with ethylene glycol as the cooling medium. The high temperature difference between the cooling liquid and the surrounding air allows a considerable reduction in radiator area to be effected as compared with water cooling. This reduction of cooling area coupled with the small frontal area (5·85 sq. ft.) of the Merlin makes it particularly suitable for high-speed aircraft.

Type.—Twelve-cylinder 60 degrees Vee, liquid-cooled.

Cylinders.—Bore 5·4 in. (137·16 mm.), stroke 6 in. (152·4 mm.), swept volume 1,647 cub. in. (27 litres). Two one-piece cylinder-blocks of cast R.R.50 aluminium-alloy have integral heads and coolant jackets. Six cylinder-liners of high carbon steel in each monobloc casting are directly in touch with cooling liquid. Spigoted flange at upper end of each liner registers in recess in head. Soft aluminium-alloy jointing ring ensures gas-tightness. Coolant joint at base of each liner where liner spigots through cylinder-block into crankcase. Joint made by rubber ring, spring-loaded in an external groove in liner, just above a flange which beds against crankcase. Fourteen long studs extend, in coolant-tight tubes, from top of cylinder-block into crankcase. Additional studs on each side of each liner secure clamps which come up against lower face of top flange of each liner and so draw liner up against cylinder-block. Renewable valve-seatings, aluminium-bronze for inlets and silichrome for exhausts, screwed

into cylinder-heads. Valve-guides of cast-iron for inlets and phosphor bronze for exhausts.

Pistons.—Machined from forgings of R.R.59 alloy. Three compression and two scraper rings. One of latter above and other below gudgeon pin. Both grooves and rings drilled to return oil from walls. Fully-floating hollow gudgeon pins of hardened nickel-chrome steel retained in position by spring circlips.

Connecting Rods.—Nickel-steel forgings machined to H-section all over. Each pair consists of plain rod and forked rod, latter carries nickel-steel bearing-block, lined inside and outside with lead-bronze. Halves of block secured together and to forked rod by four bolts. Plain rod oscillates about outer lining of block. Small-end of each connecting rod houses floating phosphor bronze bush.

Crankshaft.—One-piece six-throw. Machined forging of Vickers chrome-molybdenum steel to D.T.D.228. Integral balance-weights. Nitrogen-hardened. Crankpins and journals bored and fitted with oil-retaining covers. Drive to reduction-gear pinion is from flange bolted to front end of crankshaft. To damp out irregularities in angular velocity and torque, drive from crankshaft to supercharger and timing gears and auxiliary components is through torsionally flexible shaft which provides spring drive. Twisting of this shaft is limited by hollow sleeve.

Crankcase.—In halves. Both castings of R.R.50 aluminium-alloy to D.T.D. specification 133B. Upper and more complex portion carries cylinders, bearings of crankshaft and part of housing for airscrew reduction gear. Lower portion is sump case. Main bearings, split mild-steel shells lined with lead-bronze alloy, fit into recesses machined in the crankcase. Bearings held in position by caps. Besides usual bolts, seven pairs pass transversely through caps and across whole width of crankcase. Design gives rigidity of integrally cast bearing

cap but allows withdrawal of lower portion of crankcase without disturbing bearings.

Wheelcase.—Aluminium casting secured by studs at rear end of crankcase. Supercharger unit goes on to back of wheelcase. Latter houses drives to the camshaft, magnetos, water and oil pumps, supercharger, hand and electric starters, and the electric generator.

Valve Gear.—Two inlet and two exhaust valves of K.E.965 steel parallel to axis of each cylinder. Inlet-valves on inside of Vee have stellited ends. Exhaust valves have sodium-cooled stems and 'Brightray' over crown and seating surfaces and hardened caps of nickel-steel at ends. Each valve has two concentric coil-springs, kept in place by collar and split wedge. Spring circlip retains valve in guide should valve-springs fail. Each valve is worked through a separate steel rocker which has a spherical-headed tapper-screw and lock-nut at the valve end for adjustment. Camshaft, along top of each cylinder-block in seven bearings, driven by inclined shaft and bevel gears from wheelcase.

Induction.—Twin-choke updraught carburetter of Rolls-Royce and S.U. design supplies mixture to supercharger. Two air-passages are coupled to a single Rolls-Royce type of forward-facing air-intake. Each choke is supplied by a separate diffuser nozzle at right angles to airstream; by slow running device; by discharge orifice of accelerator-pump; and by main fuel-control jet of submerged type controlled by taper needle. Automatic and two-position mixture-control device incorporated in carburetter. One jet controlled by aneroid exposed to atmospheric pressure. In the event of failure of aneroid mixture returns automatically to full rich. Other jet controlled by aneroid subjected to boost pressure and safeguarded against damage from back-fires by a disk-valve which closes the communicating vent. Positive methods against freezing; heated coolant circulates through jackets

around chokes; warm scavenge oil circulates through hollow throttle-valves. Twin fuel pumps driven by independent quill shafts. If one pump fails, other has more than enough capacity to meet maximum demand. Any fuel in excess is returned through disk-valve to suction side.

Supercharger.—Mounted co-axially with crankshaft. In Merlin II runs at 8·558/1. Forged and machined aluminium-alloy rotor has separate unit of steel inlet guide-plates. Speed-multiplying gear comprises system of planets driven from gear on crankshaft. Planets incorporate slipping clutches. Merlin X has two-speed supercharger, change-speed mechanism of which is operated by oil-pressure from scavenge system. Delivery pressure of supercharger is controlled by automatic servo-mechanism coupled through differential linkage to throttle so that opening of latter is controlled to suit boost-pressure.

Ignition.—Two twelve-cylinder magnetos spigot-mounted, one on each side of wheelcase. Each driven by skew-gear from upper vertical drive-shaft through serrated couplings. System fully screened. Three metal conduits coupled with metal braiding to magneto-housings. Short metal-braided connections to sparking-plugs. Special heat-resisting adaptors on exhaust side.

Lubrication.—Dry-sump system. One pressure and two scavenge pumps of the gear type driven from wheelcase through idler gear from lower vertical drive-shaft to coolant pump. Pressure pump delivers oil through a triple relief-valve; first, 150 lb. per sq. in.; secondly, 70 lb. per sq. in.; and finally, for the low-pressure feed. High-pressure stage can be connected with, or shut off from, airscrew hub from pilot's compartment. Oil at this pressure is also supplied to the fuel-pump bushes. Oil from second stage, at 70 lb. per sq. in., is fed into drilled passages in crankcase and thence to main gallery-pipe which supplies main bearings. Big-end bearings fed

by oil-passages in crankwebs and holes in crank-pins. Pistons and gudgeon pins and small-ends of connecting rods lubricated by splash. Baffle in lower portion of crankcase prevents excess of oil from being thrown into cylinders. Pressure in third stage, between 4 and 8 lb. per sq. in., supplied to auxiliaries, such as camshaft, valve-rockers, generator, and supercharger-drive-gears and tail bearings. Two jets, fed from low-pressure system, spray oil on to the reduction gears. Oil-sealing ring in forward housing of airscrew shaft. Oil draining back to crankcase through camshaft-drive housings lubricates inclined camshaft-drive and wheelcase gears. Oil from valve mechanism drains into crankcase down tubes for cylinder-holding-down studs. One scavenge pump draws oil from pipe along bottom of crankcase at forward end, other draws rear sump. Separate gauze filters, on suction side of each scavenge pump, easily taken off downwards.

Cooling.—Cooling liquid, or coolant, circulated by centrifugal vane-type pump driven at one and a half times crankshaft speed. Two bends on pump casing, each with gland-type connections, deliver coolant into back lower end of each cylinder-block. After circulating, coolant leaves through three outlets along inner side of each cylinder-block. These connect with the main outlet pipe, which leads forwards or backwards as required.

Starting.—12-volt B.T.H. electric motor, mounted vertically at the right of the wheelcase, drives through Rotax reduction gear and Bendix engaging mechanism, to one of the supercharger planet gears, ratio between starter-motor and crankshaft is about 393 : 1. Auxiliary hand-turning gear with a reduction ratio of 14:1 operates through a portion of same gear-train as electric starter. Multiplate clutch, common to both systems, incorporated on the starter-layshaft, is designed to slip in the event of a backfire.

Accessories.—12-volt 500-watt electric generator driven at

1·914 times crankshaft speed by gear train from one supercharger planet wheel. Spider-couplings connect the drive and dynamo armature-shaft through a fabric disk. Revolution-counter drive-connection at the rear end of left camshaft runs at one-quarter crankshaft speed. Drives also on the left and right cylinder-heads respectively for one low-pressure and one high-pressure air-compressor. Special drive for a Lockheed undercarriage pump on the lower portion of the crankcase is driven from gear which drives the main oil pump through a bevel train. A pump for the operation of gun-turrets may be driven from the right camshaft. Provision is made for drive to constant-speed unit of the airscrew from reduction gear pinion, and for a vacuum pump, Pesco, Romec, or Rotax-Eclipse to work the blind-flying panel, automatic pilot or de-icing equipment.

Airscrew Drive.—Airscrew shaft driven through single spur reduction gear (·477/1) at the front end of crankcase. Hollow driving pinion in two roller-bearings co-axial with crankshaft from which it is driven by a short hollow shaft serrated at both ends. One end engages with crankshaft flange and forward end with internal serrations on driving pinion. Hollow shaft insulates pinion bearings from the crankshaft loadings. Pinion engages with toothed ring bolted to flange integral with hollow airscrew shaft. This runs on roller-bearings and has ball-bearing which takes axial thrust in either direction. Airscrew shaft takes 'Rotol' or the De Havilland Hamilton variable-pitch airscrew. High-pressure oil for operation of hydraulic airscrews supplied through a tube secured within and rotating with the shaft. This tube is fed from spherically-seated oil-connection in the housing of the rear half of the reduction gear casing. Airscrew hub is centralized upon cones at each end.

	Merlin II, III, IV	*Merlin X*
Number of cylinders	12	12
Bore	5·4 in. (137·16 mm.)	5·4 in. (137·16 mm.)
Stroke	6 in. (152·4 mm.)	6 in. (152·4 mm.)
Capacity	1,647 cu. in. (27 litres)	1,647 cu. in. (27 litres)
Compression ratio	—	—
Rotation	R.H.	R.H.
Gear ratio	0·477/1	0·477/1
Length	75·078 in. (1,907 mm.)	—
Height	41·175 in. (1,045 mm.)	—
Width	29·825 in. (758 mm.)	—
Weight (net dry)	1,335 lb. (605·5 kg.)	1,394 lb. (633 kg.)
Take-off power	1,030 h.p. at 3,000 r.p.m.	1,075 h.p. at 3,000 r.p.m.
International rating	990 h.p. at 2,600 r.p.m. at 12,250 ft. (3,810 m.)	Low gear: 1,035 h.p. at 2,600 r.p.m. at 2,250 ft. (685 m.) High gear: 960 h.p. at 2,600 r.p.m. at 13,000 ft. (3,960 m.)

	Merlin II, III, IV	Merlin X
Maximum power	1,030 h.p. at 3,000 r.p.m. at 16,250 ft. (4,940 m.)	Low gear: 1,130 h.p. at 3,000 r.p.m. at 5,250 ft. (1,525 m.) High gear: 1,010 h.p. at 3,000 r.p.m. at 17,750 ft. (5,400 m.)

THE MERLIN X

(*Two-speed supercharger*)

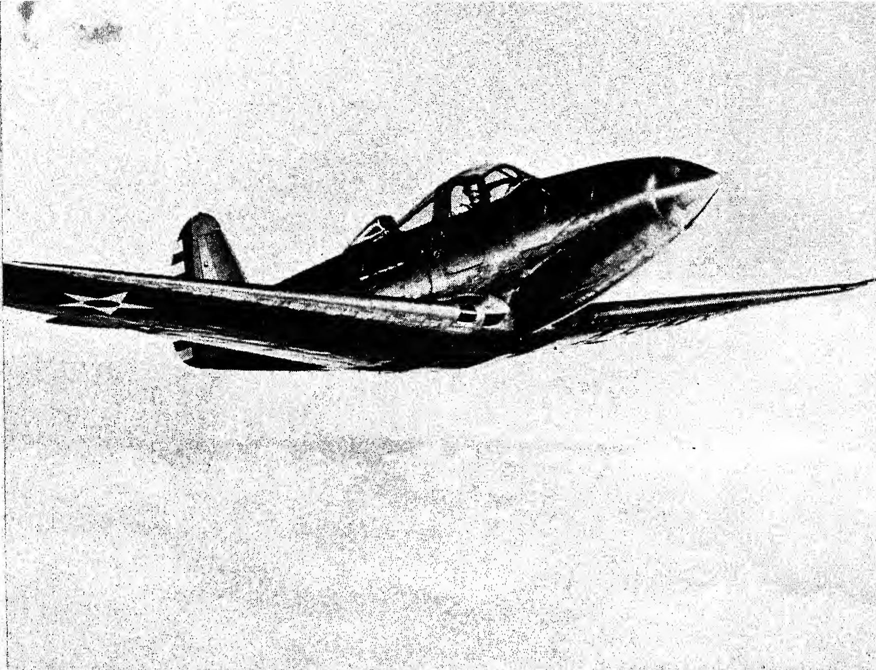
Performance (moderate gear).—International rating 1,000/1,040 h.p. at 2,600 r.p.m. at 2,500 ft. (762 m.). Maximum power 1,145 h.p. at 3,000 r.p.m. at 2,250 ft. (1,600 m.). Take-off 1,025/1,065 h.p. at 2,850 r.p.m.

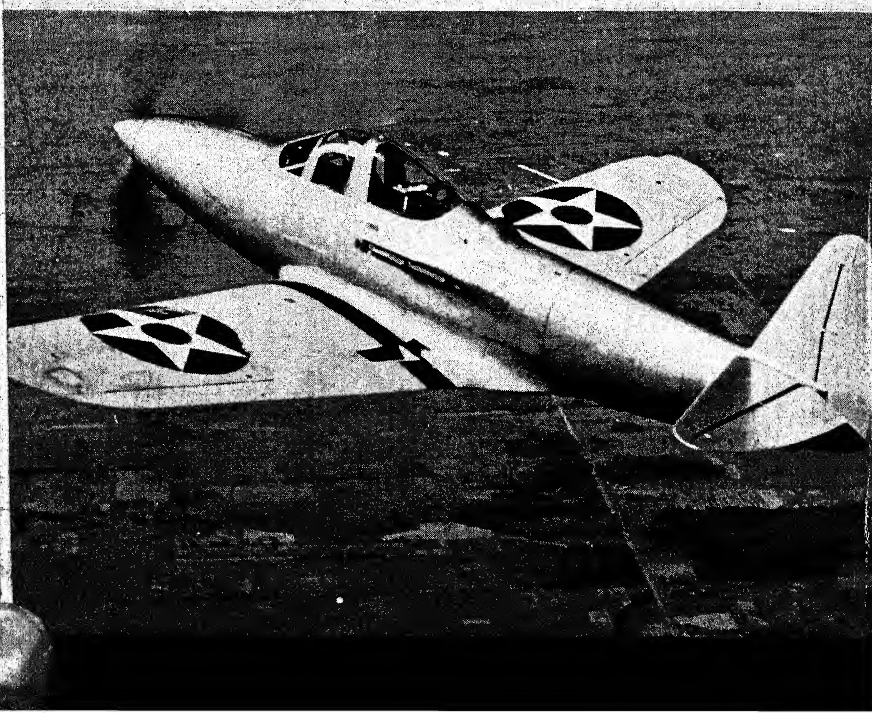
Performance (full supercharge).—International rating 930/965 h.p. at 2,600 r.p.m. at 13,250 ft. (4,039 m.). Maximum power 1,025 h.p. at 3,000 r.p.m. at 17,750 ft. (5,410 m.).

PART V

THE AMERICAN PLANES

Plate 15. Douglas Boston and Brewster Buffalo





Chapter 30

THE AMERICAN FIGHTERS

Although this small book is primarily concerned with English fighting aeroplanes (there are no Scottish or Welsh or Irish), I feel that something should be said about the American fighters which are coming into service with the R.A.F.

Now that the U.S. Lease and Lend Bill has become law we are promised a half-share of America's best aircraft, and no doubt they will before long become as effective as our own. I cast no reflection on American designers when I say that, although their machines fly beautifully, they had neither the speed nor the armament of ours until well on in 1941. That was only natural, seeing that the R.A.F. has been unceasingly at war since the 4th August 1914 (more than twenty six years) in one part of the British Empire or another, and so the British aircraft designers know more about designing warplanes than can be known by designers of any other country.

America's first contribution to the R.A.F., before war was declared, was the Lockheed Model 14, a twin-motor twelve-passenger monoplane, built by the Lockheed Aircraft Corporation, of Burbank, California. It was intended for use as a 'conversion-course' trainer, in which pilots of single-motor craft could be taught to fly with two motors, and as a flying class-room for air navigators. On the out-

Plate 16. Bell Airacobras

break of war, because of the reliability of its Wright Cyclone motors, it became a reconnaissance craft in the Coastal Command. A big gun-turret was fitted aft, and later on guns were poked out of the windows, to defend the blind spots. It became a bomber and fighter and anything else that was wanted. Its success was a triumph of improvisation.

Almost at the same time the R.A.F. bought some NA-16-3 (Export title, BC-1A) two-seat, single-motor monoplanes, made by North American Aviation Inc. of Los Angeles. These had a Pratt and Whitney Wasp motor of 550 h.p. and were originally regarded as a species of warplane, but a little experience showed that they were quite useful advanced trainers, to take pupils on from primary school craft to real first-line fighters or bombers.

Since then the U.S. designers, who are always quick and ready to learn, have profited by the successes in the air of our English fighters and bombers, and to a great extent by the disastrous fate of the French, whose gallant pilots suffered from having no first-class fighting aeroplanes, because they were betrayed by a succession of politicians.

To-day the fighters from the U.S.A., which have always flown beautifully—because they have been very good *as aeroplanes*—are being properly armed and engined, and some of them may fairly be classed as first-line fighting-machines.

Hereafter is a list of those American fighters which have been definitely adopted into the R.A.F. and the Fleet Air Arm. They are given in alphabetical order of the names used over here, except where we have not re-named them—why they need have been re-named has not been explained—and the name or number given by their makers follows. The English names are in italics, the American names in quotation marks. The fact that motors of the same name give different powers is explained by the fact that there are dif-

ferent types of the same motor which have different compressions and rates of supercharge.

Boston.—Douglas D.B.7 (or 7.A or 7.B, according to motors fitted). Two Pratt and Whitney Cyclones of 1,600 h.p. each. Speed 370 m.p.h. Four fixed machine-guns in nose. Three-seat fighter.

Buffalo.—Brewster X.F.2.A-2 (Export Model 339). One Wright Cyclone of 1,200 h.p. Speed 330 m.p.h. Two machine-guns firing through airscrew by interrupter gear, two in wings. Single-seat fleet-fighter in U.S. Navy, second-line land fighter in R.A.F.

Caribou.—Bell P.39, 'Airacobra'. One Allison liquid-cooled motor of 1,000 h.p. Speed 400 m.p.h. One 37-mm. cannon firing inside airscrew shaft, 4 or 6 machine-guns of ·303 calibre in wings. Single-seat fighter.

'Lightning'.—Lockheed P.38. Two Allison liquid-cooled motors of 1,000 h.p. each. Speed more than 400 m.p.h. One cannon and four machine-guns all fixed in nose. Single-seat fighter.

Martlet.—Grumman X.F.4.F-3 (G-36) monoplane. One Wright Cyclone of 1,200 h.p. Speed 330 m.p.h. Two synchronized machine-guns in nose, two more in each wing. Single-seat fighter for Fleet Air Arm.

Mohawk.—Curtiss 'Hawk' 75-A. One Wright Cyclone of 1,200 h.p. Speed 323 m.p.h. Two ·5-in. synchronized guns in fuselage, and two ·303s in each wing.

Mustang.—North American Aircraft Corp. N.A.-73. One Allison motor of 1,000 h.p. Speed reputed to be 400 m.p.h. Armament unknown. Single-seat fighter.

Tomahawk.—Curtiss P.40 (or Export title 'Hawk' 81-A). One Allison motor of 1,000 h.p. Speed 330 m.p.h. Two guns synchronized in fuselage and four guns in wings. Single-seat fighter.

'Vanguard'.—Vultee 48 (or 61). One Cyclone of 1,200 h.p.

Speed 350 m.p.h. Two synchronized guns in fuselage and three in each wing. Single-seat fighter.

Those are all the American fighters—for the present.

Just to have them on record I may as well add the other American aeroplanes which are being leased or lent to us. Names in italics are those given by the R.A.F., those in quotations are the American names.

Bombers.—The Consolidated *Liberator*. Four Pratt and Whitney Twin Wasps of 1,200 h.p. each; 320 m.p.h. The Martin *Maryland*: two Twin Wasps of 1,050 h.p. each; 305 m.p.h. The Douglas *Digby*: two Wright Cyclones of 1,200 h.p. each; 220 m.p.h. The Douglas *Boston* (bomber): two Twin Wasps of 1,050 h.p. each; 320 m.p.h. The Boeing 'Flying Fortress': four Cyclones of 1,200 h.p. each; 268 m.p.h. The Lockheed *Hudson*: two Cyclones of 1,100 h.p.; 260 m.p.h. The Lockheed 'Ventura': two Twin Wasps of 1,200 h.p. each; 260 m.p.h.

Dive-Bombers.—The Douglas D.B.8A: one Twin Wasp of 1,050 h.p.; 260 m.p.h. The Brewster *Bermuda*: one Cyclone of 950 h.p.; 255 m.p.h. The Voight-Sikorsky *Chesapeake*: one Twin Wasp Junior of 800 h.p.; speed 255 m.p.h. The Curtiss *Cleveland*: one Cyclone of 1,000 h.p.; 240 m.p.h.

Flying-Boats.—The Consolidated *Catalina*: two Twin Wasps of 1,200 h.p.: 199 m.p.h. The Consolidated 31: two Duplex Cyclones of 2,000 h.p. each; 200 m.p.h.

Trainers.—The North American *Harvard*: one Wasp of 550 h.p.; 206 m.p.h. The North American *Yale*: one Wright Whirlwind of 420 h.p.; 170 m.p.h.

THE LAST WORD IN FIGHTERS

Lord Beaverbrook, Minister of Aircraft Production, announced in the House of Lords on April 23rd the existence of a new single-seat fighter called the *Typhoon.* The Press was allowed to say something about it on and after April 27th. Naturally no details may be published, but we can give a general idea of the machine and its motor, the Napier Sabre.

THE TYPHOON

Those who are on the inside of the British aircraft industry have known for the past two or three years that Mr. Sidney Camm, Chief of Design, and his staff in Hawker Aircraft Ltd. have had on the stocks, and for more than a year, in the air, two single-seat fighters, one with a Rolls-Royce Vulture motor and one with a Napier Sabre, which would in due course supersede the Hurricane. The American Press got to hear of the Tornado and published a lot of fact and fiction about it. But somehow the Typhoon was kept dark. Even in this country few people knew of its existence.

Actually the first Typhoon, the prototype, as the first sample of a new type is called, flew in February 1940—nearly fifteen months before its existence was made known. Since then, in the hands of Flight-Lieutenant P. W. S. Bulman (also a Director), commonly called George, and Flight-Lieutenant Lucas, the firm's chief test pilots, it has done all the usual Service tests, which include not only fighting manœuvres, speed, climb, quickness in handling and so forth, which concern the pilot, but also tests of its serviceability, as one might call it, that is the degree of ease with which its

working parts can be inspected and repaired and replaced, and the quickness with which it can be refuelled and re-armed after a fight. In every way the Typhoon has come well out of its tests.

In appearance, at a distance, it is not unlike a Hurricane—which may be awkward for any German pilots who, in the latest German products, think that they can easily dodge, or defeat or out-distance an old Hurricane. For the Typhoon packs a cargo of guns and ammunition which would have seemed fantastic even a few months ago. Naturally cannon-guns are part of the armament—or, if needed, can be all of it. The machine is so big and powerful that it can carry any sort of armament in hitherto unknown quantities.

With 2,400 h.p. instead of 1,100 h.p. its speed is naturally far higher than that of the older fighters, in spite of the machine itself being bigger. It is given as 'more than 400 m.p.h.' How much more is an official secret, which the Germans are likely to learn by bitter experience sooner than we do.

The Tornado and the Typhoon, originally alternative designs for fighters, have been developed along differing lines, each for its special purpose, which the enemy will also discover. Sir Frank Spriggs and Mr. H. K. Jones (see the chapter on the Hurricane) are to be congratulated on their latest success.

THE NAPIER SABRE

Few aero-motors have an odder genealogy than has the Napier Sabre. The makers, D. Napier & Son Ltd., began by making roller skates, somewhere about the skating boom (they always come in epidemics) of 1890. When the boom died the Napier Company survived as engineers, and about 1900 took to making motor-cars. Montague Napier, son of D. Napier, was the head of the firm—and being consumptive he had to leave much of the work to others Thus H. T. Vane, who had been London Manager for the Dunlop Company, took charge.

During the War of 1914–18 the Napier Company were turned on to make the 12-cylinder Raf (Royal Aircraft Factory) air-cooled Vee motor, evolved from the old French 8-cylinder Renault air-cooled 80 h.p. of 1912–14. The Napier

Company made the Raf into quite a good engine of 130 h.p.

Thus encouraged by success, H. T. Vane let Captain Wilkinson, their technical chief, design a W or broad-arrow type water-cooled engine, which had three blocks of four cylinders each—two in Vee, and a third standing vertically between them. This was called the Lion. It gave about 450 h.p. and did a lot of good work in the R.A.F. It was, in fact, the first engine in the Service to run habitually for 450 hours between overhauls.

In 1927 and 1929 Napier Lions were specially tuned for Schneider racers, and put up a very good show at Venice and over the Solent. But the Lion gave place to the Rapier, the Dagger, and now to the Sabre, which have as interesting a genealogy of their own on the other side.

In 1910 a young engineer named Frank Halford learned to fly, and became an instructor with the Bristol Company at Brooklands. When war began in 1914 he went to France with the Royal Flying Corps, but was brought back and put into a technical job.

About then the Hispaño-Suiza Company struck the brilliant idea of making a motor with aluminium cylinders inside which were steel liners to take the kick of the pistons. At that time Beardmores, on the Clyde, were making aeroplanes, and were also building Austro-Daimler 6-cylinder-in-line aero-motors at the Arrol-Johnston Works at Dumfries, in charge of H. C. Pullinger.

So Frank Halford designed a lighter and more powerful version of the Austro-Daimler, with aluminium cylinders and steel liners, which was used in the De Havilland 9 (D.H.9) as the 220 h.p. B.H.P. (Beardmore-Halford-Pullinger, or Brake-Horse-Power, as you will). It was put into big production by Siddeley Motors Ltd. and became the Siddeley Puma, which did much work in civil aviation after the war.

When the war ended Frank Halford joined the Aircraft Disposal Co. Ltd., founded by Mr. F. Handley Page and Mr. Godfrey Isaacs, brother of Lord Reading, which bought all the Air Ministry surplus to sell for what it could get. It got millions, and paid £6,000,000 to the Government, to the relief of the tax-payer.

Halford's job was to see that disposals engines were fit for

re-sale. He once showed me one shop in which were engines which cost this country £5,000,000.

While there the light aeroplane boom began. Halford took four cylinders of a Renault, its own crankshaft, camshaft, pistons, valves, etc., put them on to a new crankcase, and produced the 80 h.p. Cirrus I—as much out of four cylinders as originally came out of eight. De Havilland's took lots for their Moths. Then they decided to make their own engine. Halford designed it for them and called it the Gipsy.

Then the Gipsy was made a 6-cylinder job, and was turned upside down to run inverted, and gave 130 h.p. So Halford took two of them and made an inverted Vee of them. That did not go into production because he went farther and took four of the 4-cylinder Gipsies and made an H-type, with 16 cylinders—that is two double-opposed 8-cylinder jobs, coupled to a central air-screw shaft.

That was too big for De Havilland needs, so the Napier Company—whose Lions were becoming obsolete—except for Mr. Scott Paine's excellent power boats—took it over, and called it the Napier Rapier. It gave 393 h.p. Halford, grasping after still higher things, then made a 24-cylinder engine, practically four Gipsy IIIs. It became the Napier Dagger, a very fine motor, which runs like silk and gives 925 h.p. at a moderate estimate. It has been largely used in Handley Page Herefords—a version of the Hampden bomber, made by Short & Harlands of Belfast.

Now the Sabre, the biggest of the 'edged tool' class, has arrived. Officially its power is given as about 2,500 h.p., which makes it the most powerful aero-motor in the world.

I believe that we are allowed to say that it is liquid-cooled. Also it is much shorter, and therefore has a smaller moment of inertia longitudinally than has any of the big engines in any country, which helps with the astonishing manœuvrability of the Typhoon, and with its stated ability to stand on its tail and go on climbing.

Credit is due to Sir Harold Snagge, K.B.E., Chairman of Napiers, Mr. C. W. Reeve, the Managing Director, and to Air Vice-Marshal Amyas Borton, D.S.O., another Director, for having taken up this novel engine—and to Mr. H. P. Savage, lately made a Director, who has been in charge of the firm's technical development.